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WORLD CROPS

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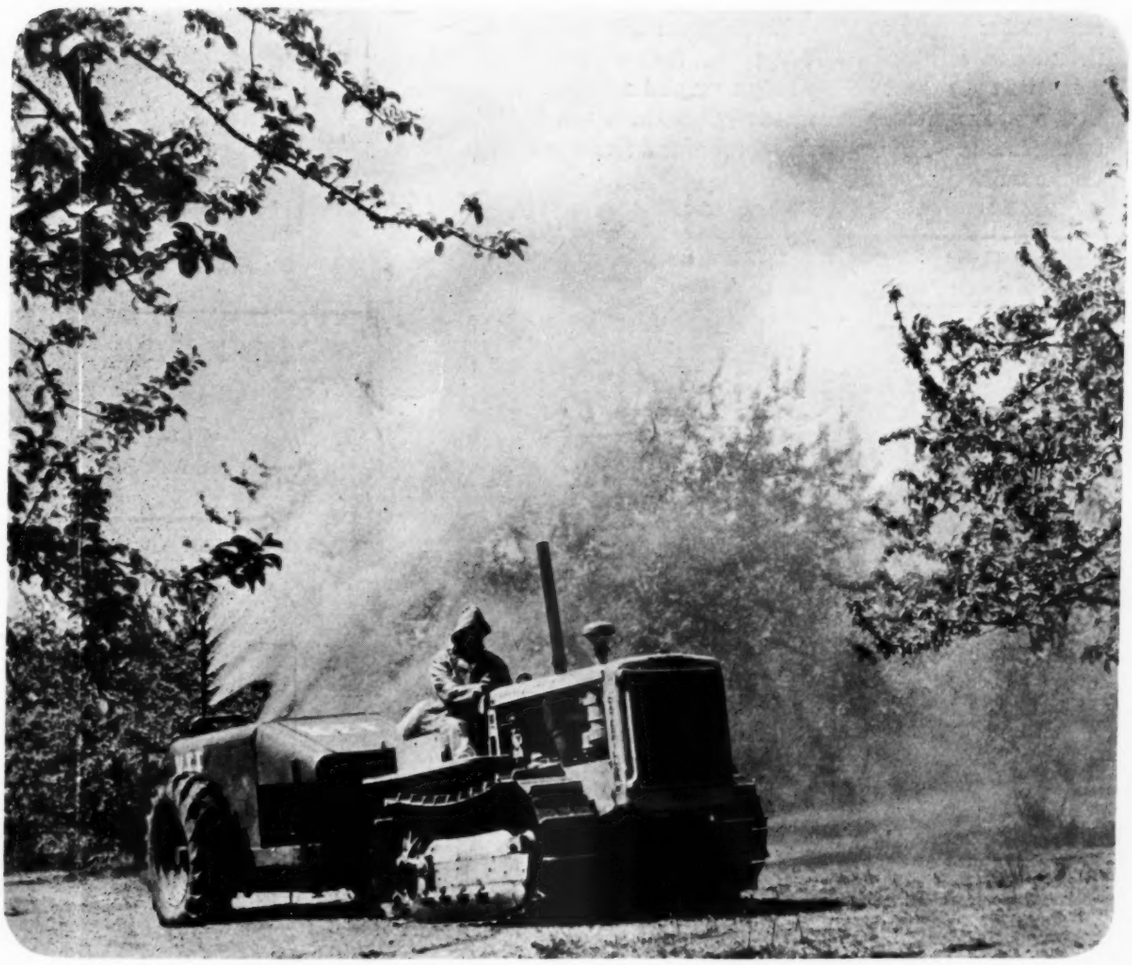
AGRONOMY, HANDLING, PROCESSING, STORAGE AND PROTECTION SOILS, CHEMICALS, IRRIGATION, ENGINEERING AND ECONOMICS

VOLUME 7, No. 11 **NOVEMBER 1955**

A Publication of The Leonard Hill Technical Group



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10 AND 14 DISC MODELS

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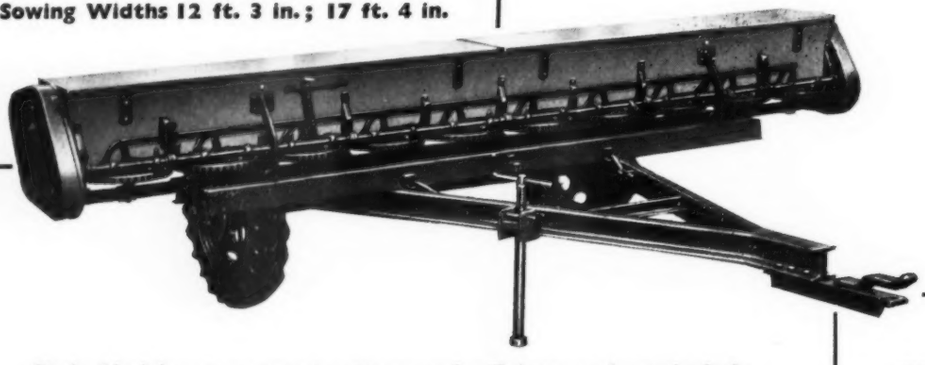

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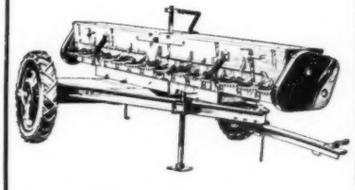

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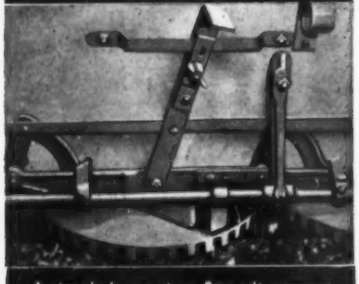

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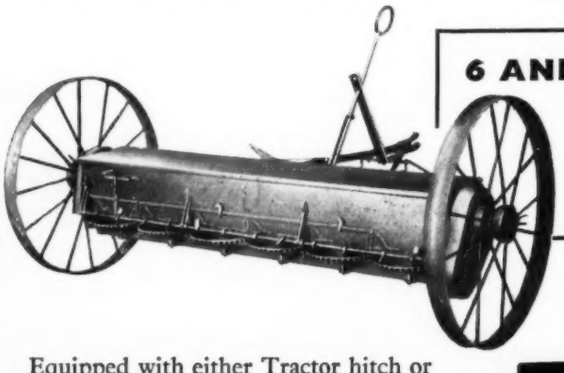

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8 ft. 7 in.

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WORLD CROPS

Vol. 7, No. 11 NOVEMBER 1955

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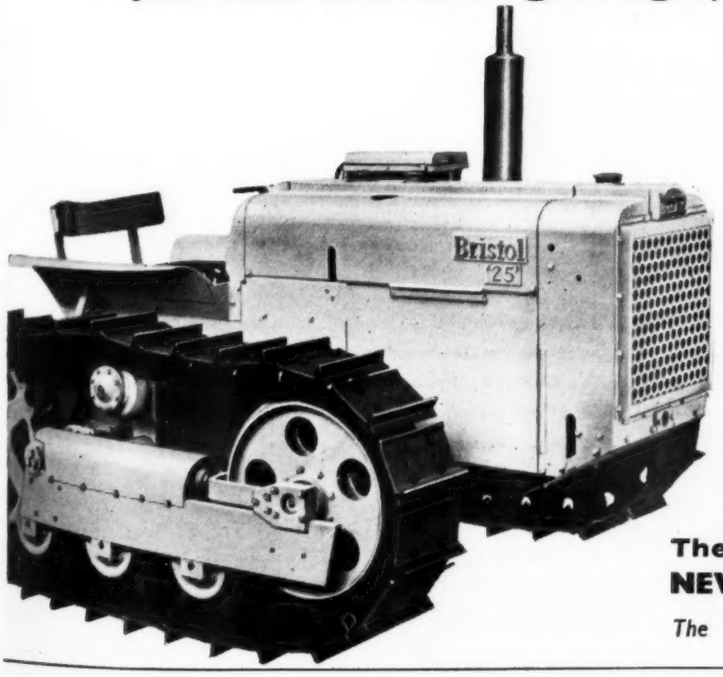
—you need this NEW lightweight, power-packed crawler



Work slopes that no wheeled tractor can tackle—in complete safety—up and down, *and across*—with this new, better Bristol '25'. The *new* Bristol '25' does every on-the-farm job. Its 2-ton drawbar pull makes light work of two- and three-furrow ploughing, land clearing, timber extraction—every job that calls for real power. Its manœuvrability and accurate steering make it equally useful in close, row-crop work. This powerful *new* crawler has all-steel, trouble-free tracks, ground pressure of only 4½ lbs. per sq. in., economical Diesel or V.O. engine, etc. Write at once for free, fully-illustrated catalogue.

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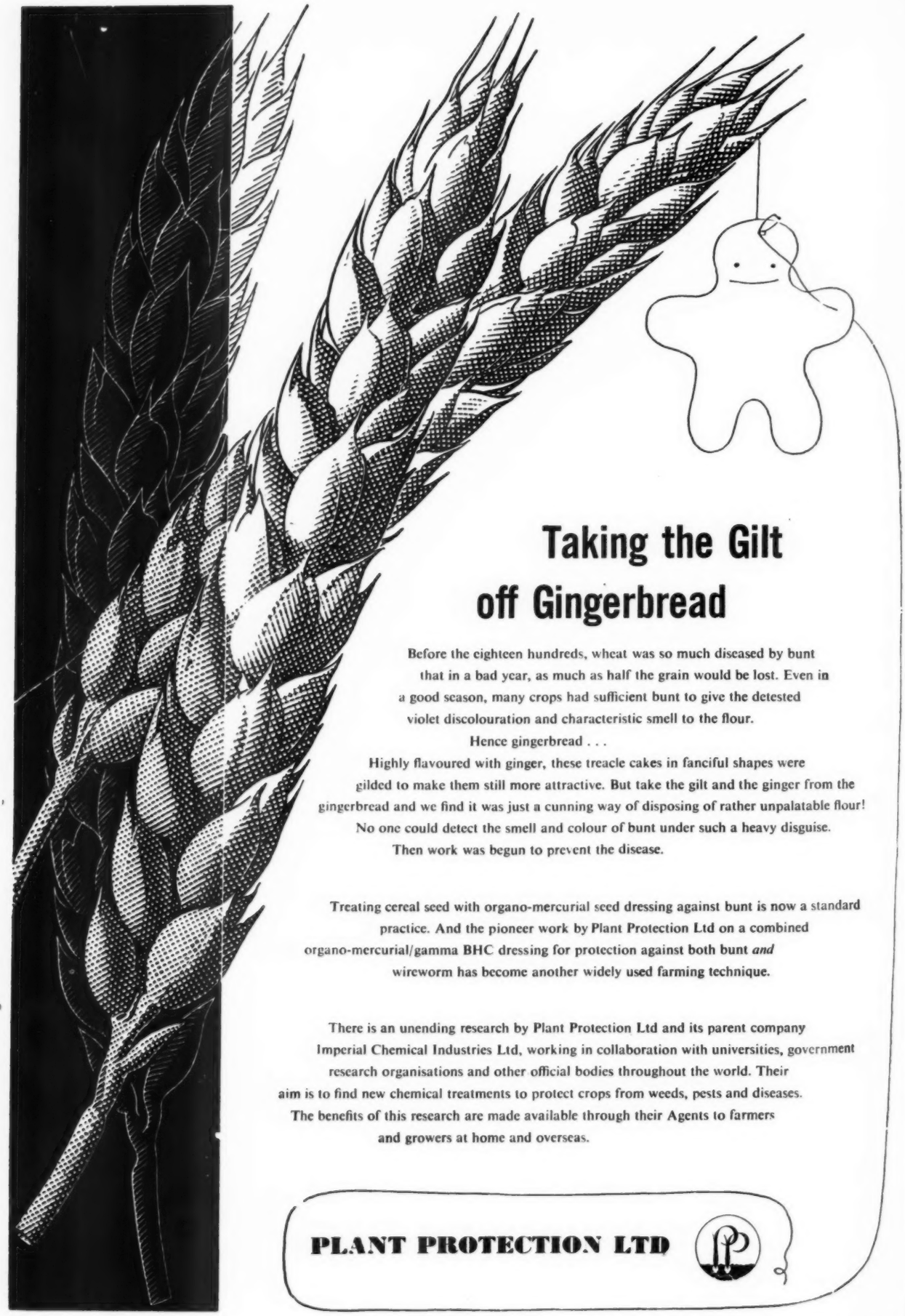

Taking the Gilt off Gingerbread

Before the eighteen hundreds, wheat was so much diseased by bunt that in a bad year, as much as half the grain would be lost. Even in a good season, many crops had sufficient bunt to give the detested violet discolouration and characteristic smell to the flour.

Hence gingerbread . . .

Highly flavoured with ginger, these treacle cakes in fanciful shapes were gilded to make them still more attractive. But take the gilt and the ginger from the gingerbread and we find it was just a cunning way of disposing of rather unpalatable flour! No one could detect the smell and colour of bunt under such a heavy disguise.

Then work was begun to prevent the disease.

Treating cereal seed with organo-mercurial seed dressing against bunt is now a standard practice. And the pioneer work by Plant Protection Ltd on a combined organo-mercurial/gamma BHC dressing for protection against both bunt *and* wireworm has become another widely used farming technique.

There is an unending research by Plant Protection Ltd and its parent company Imperial Chemical Industries Ltd, working in collaboration with universities, government research organisations and other official bodies throughout the world. Their aim is to find new chemical treatments to protect crops from weeds, pests and diseases. The benefits of this research are made available through their Agents to farmers and growers at home and overseas.

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Editorial Comment

Outlook in Latin America

A RECENT publication of the Food and Agricultural Organisation of the United Nations, 'Report of the Third Regional Meeting on Food and Agricultural Programs and Outlook in Latin America, Buenos Aires, 1–10 September, 1954', describes in detail the present situation in Latin America and makes recommendations for its improvement.

The meeting examined the present situation in Latin America as regards the production, distribution and consumption of food and other agricultural products, including fisheries, and studied the supply and demand outlook according to plans extending to the agricultural year 1956–57. In the light of this outlook, recommendations were made for the formulation of national production and consumption policies and programmes, and also for measures to improve the organisations and the means by which these programmes may be put into operation.

In order to orient countries in the formulation of their future agricultural policies, the meeting was obviously unable to make an overall recommendation, which would include all the countries, since each one has its own particular problems and different situations. The report deals with the various aspects of the problem and makes recommendations under each head.

On the subject of better co-ordination of regional production, the meeting recommends that, whenever necessary, governments should reorientate their long-term production plan with a view to improved intra-regional co-ordination. Pointing out that the policy changes based on a better co-ordination of agricultural production between the various countries can only bring about the desired effect after a considerable period, the report suggests immediate solutions to the problem of shortages and improvement of nutritional levels. 'During the last four years agricultural production in the region has only increased at a rate of 2% per annum. Unless this rate is modified, it evidently will not be sufficient to keep pace with the growth of population, which, in the near future, is estimated at a rate of 2.4% per annum. As for total demand, even assuming a *per caput* income rise of only 1% per annum and a factor of 0.5 for the income-elasticity of demand, production would have to rise at an approximate annual rate of 3%'.

Dealing with improvement of nutrition, the meeting recommends that the practice be generalised among Latin American governments of determining for each region the minimum cost of a suitable family diet, establishing it as the basis for determining wages.

The report devotes considerable space to problems of prices, trade and surpluses of agricultural products and recommends that, with due regard for national requirements, Latin American countries should re-examine and, where appropriate, modify the trend recently evidenced towards self-sufficiency in agriculture, co-operate among themselves with the aid of selective criteria for agriculture, and intensify their intra-regional trade in accordance with rational, ecological and economic criteria, thus avoiding indiscriminate expansion which would lead to an accentuation of the surplus problem.

Manures or fertilisers?

AT one time fertilisers were looked upon as substitutes for, or competitors with, animal manures. Later the more moderate view that their uses were complementary came into a fairly settled acceptance. There are signs now that some return to the older view is achieving support. Some months ago a practical farmer who has converted some hundreds of acres of thin 'useless' downland into productive cereal land delivered a cold shock to an eminent agricultural gathering by telling them that he *sold* all the farmyard manure he produced, and that he could maintain the organic matter content of his soils with the root residues from leys and arable crops. A paper by two Rothamsted scientists in the last issue of the Royal Agricultural Society's Journal reviewed all the evidence for 'organic matter' and reached the tentative conclusion that its supply by amendments was not essential for all types of soil. This paper rightly pointed out that all evidence for the virtues of farmyard manure was set against conditions of under-optimum use of fertilisers. The question posed is fair enough—in the presence of optimum dressings of fertilisers, would the crop responses to manures be significant?

A remarkable pointer has emerged from agricultural economics research. On 65 Midlands farms the costs of sugar-beet growing have been surveyed by the University of Manchester. On 41 of these farms farmyard manure plus fertilisers were used; but on 24 only fertilisers were applied. On those farms using manure approximately £3 less per acre was spent on fertilisers, but their average yield per acre was 13 cwt. less than the average yield for the farms using fertilisers without manure. This might be looked upon as a small price to pay for the long-term value of manure applications in crop rotation. In the realistic light of economics, however, the *cost of applying* farmyard manure has to be considered. This was £3 per acre higher than the cost of applying fertilisers alone. Even though no

higher cost than 15s. per ton was set upon farmyard manure, the gross costs of manure plus fertilisers were nearly £6 per acre greater than the gross cost of fertilisers only. It is a high premium to pay for a treatment that produces a smaller immediate yield.

How far can root system residues adequately maintain organic matter contents of soils? And on what types of soils can this means of maintaining organic matter be relied upon so long as fertilisers provide the plant nutrients? An entirely new research programme is required to settle these points.

Know-how and why

WHAT is it that induces a farmer to adopt some new technical method? An all-important question, for by nature few commercialists are more conservative than farmers. A joint effort by survey-questionnaire means has been carried out by the Iowa State College and TVA to find out why a farmer decides to use a new fertiliser. Over 500 farmers were interviewed by random selection. Statistically this size of sample was calculated to be representative; frankly, however, we must comment that to us the number seems dangerously small for such a claim.

The main influence towards *deciding to use* a new type of fertiliser is recommendation by other farmers. Of the farmers interviewed, 66% admitted this. This influence was considerably stronger than that of ' mass media ', *i.e.* newspapers, journals, radio, TV, etc., whose second-place score in the survey was 18%. Public agencies, *e.g.* advisory services, agricultural colleges, and so on, took third place with 10%. The only other measurable influence was that of the fertiliser salesman or dealer, and this rated no higher than 4%. The remaining 2% covered the usual ' do-not-know ' range. It is very clear from these results that in Iowa *what farmers say* counts a great deal more in expanding a new product's use than anything that other people say. Most people with intimate knowledge of farming in Britain would expect a somewhat similar result here.

This concerns the actual decision to buy and use a new fertiliser, the critical step of *acceptance*. So far as obtaining information about a new fertiliser is concerned, the balance of influences is very different. This equally important stage in arriving at a decision, the preliminary stage of becoming aware that a new fertiliser is available and should be considered, is most dominantly influenced by public agencies. Their influence reached a ' score ' of 69%. The next highest influence was that of the salesman or dealer, 12%. The influences of ' other farmers ' and of ' mass media ' were only 4 and 5% respectively.

Obviously market-building for a new agricultural product must be regarded as a two-stage process, with ' getting it known ' as the first stage and ' getting it used ' as the second. It is a little paradoxical that the influence of personal-contact salesmanship should be so much stronger in the first stage than in the second, but this undoubtedly reflects the scepticism of farmers. The realisation that the product genuinely merits interest depends upon official support and recommendation—if official advisory services seem uninterested, most farmers will remain uninterested. The second stage, converting interest into use, has a vicious circle problem. Some farmers must first become successful users and subsequently their enthusiasm will speedily widen the market. Clearly, a most critical factor is to secure the *right* pioneer-users in any area, farmers who are not only skilled and progressive, but who will willingly pass on information to other farmers.

It is true that this survey covered only a single state in the U.S.A. and was related only to fertiliser use, but the findings are so clear-cut that it seems reasonable to assume that their general implication will apply much more widely and also to other agricultural products.

IFAP in Rome

REPRESENTATIVES of more than 25 million farm families met at a world farm organisation meeting in Rome recently and talked about agricultural surpluses, international trade problems and markets.

The Eighth General Meeting of the International Federation of Agricultural Producers (IFAP) was officially opened by the President, Mr. A. B. Kline. The U.S. Secretary of Agriculture, Mr. E. T. Benson, was a featured guest speaker and so was the Italian Minister of Agriculture, Signor Emilio Colombo. Approximately 200 delegates and observers from all over the world attended the sessions held in the conference rooms at FAO headquarters. IFAP is a non-governmental organisation and is an international spokesman for farmers.

Signor Colombo welcomed the delegates to Rome and hoped the meeting would be a fruitful one. He said, ' Although complex and varying from product to product, the problem of cost evaluation, the balance between cost and price, and the balance between prices of various commodities on the home and foreign markets may ever find more favourable solution in the co-operation between different countries . . . '. The Italian Minister continued by saying that an expert solution to economic problems in general and agriculture in particular can only be sought in full co-operation between governments, professional groups and farm organisations.

Discussing his attendance at IFAP's first meeting, the U.S. Secretary of Agriculture said, ' Back in 1946, as we discussed the future of world agriculture in London it seemed there could never be quite enough to meet the minimum requirements of a hungry world

. . . then it was a problem of too little. I am sure that none of us envisioned a problem of too much so soon '. Mr. Benson spoke of IFAP's role in world agriculture, saying, ' Through the intervening years the International Federation of Agricultural Producers has concentrated its major attention upon promoting better understanding among farmers and their various organisations throughout the world. It has given valuable assistance to governments in the formulation of agricultural policies and programmes designed to help the under-developed countries. It has avoided domination by any single group or country. It has preserved its status as a representative, world-wide organisation of agricultural producers '.

Mr. Kline told the conference that farmers need to adjust their production to meet the market. ' From the farmer's standpoint we shall, I think ', he said, ' have to learn that our products must not only be produced, but that they must be used. If we develop production ahead of markets, we shall suffer from low prices and depressed conditions among farmers everywhere '. Mr. Kline also spoke of surpluses and said that they are simply supplies which are not used and are greater than amounts normally carried on hand.

Problems other than the world food reserve were discussed by the delegates. They included the prospects and proposals for an international wheat agreement; the present wheat agreement expires in 1956.

Discussions also centred on national agricultural situations, problems and policies; international economic, trade and payments positions, with particular reference to agricultural products; and possible national and international actions. One of the papers debated noted that almost every government in the world is intervening in one way or another in supporting the prices of basic crops and livestock products. ' The problem of how these national support actions can be co-ordinated through international co-operation to prevent unstable prices will be one of the main discussion points at the meeting ', said the IFAP Secretary-General, M. Roger Savary.

Further points on the outcome of the meeting will be published in the next issue of WORLD CROPS.

'Paint your wagon'

MUCH has been said in recent years of the psychological effect on the industrial worker of the colour schemes used in factory buildings. Indeed, it would seem that factory managers, and other students of ' human relations in industry ', are devoting considerable attention to their interior decorating. One wonders, however, whether such concern for the welfare of employees is, or could be, extended to the farms, particularly in view of the reported drift of labour from the land into industry.

A recent British newspaper report stated that the walls of many thatched cottages in the country are now receiving pink washes. We have, of course, heard about farmers who claim that they can increase their milk production by playing certain types of music to their cows, but we have yet to hear of barns with mauve walls and Siamese pink rafters. Such a delicate blending of nostalgic colours may not increase milk production, but it may well make the young farm worker think there is more in farming than meets the eye.

Travelling about the country one sees, unfortunately, many dilapidated-looking farm buildings that would undoubtedly benefit from a coat of paint of any colour. It is possible, of course, that the owners of these buildings feel that their ramshackle appearance lends a certain rustic air to the scene. This somewhat suspect aesthetic sense may not, however, be shared by his employees, and it would certainly be of interest to study the effect on the ' weary ploughman ' of a delphinium blue tractor with puce wheels.

Grassland=cheaper food

THE paper on ' Utilisation of Grassland ' read by Mr. R. A. Hamilton at the Bristol meeting of the British Association for the Advancement of Science was not only notable in a meeting of many excellent papers, but outstanding as a contribution to one of agriculture's most discussed complexities. More than two-thirds of the world's agricultural land is under grass, permanent or temporary. Grazed grass is the cheapest form of animal food, and conserved grass one of the cheapest. Yet, on the whole, the nutrient possibilities of grass are either neglected or sadly underexploited. If most of Mr. Hamilton's paper dealt with the case of British grassland, his theme nevertheless had many other national applications. He cited OEEC figures for average output of starch equivalent per acre in European countries: Netherlands, 26.2; Denmark, 22.3; Belgium, 20.0; Norway, 19.0; Western Germany, 17.2; Britain, 16.7; France, 11.1 cwt.' These are much larger variations than climatic differences can possibly explain.

Grass production is only one side of the coin in this matter; utilising the grass that can cheaply and easily be grown by modern methods is the other. Grazing, the simplest means of utilisation, is seasonally limited in most countries. Preserving grass for winter feeding is the crux of the problem. If Mr. Hamilton's reasoned plea for a greatly expanded making of grass silage receives support, there can be an abundance of food and, perhaps more importantly in the years ahead, an abundance of cheaper foods of the kinds most needed—dairy products and meat.

The British case is typical enough. Of the grass that is conserved, 95 % is in the forms of hay or silage; of this 95 %, nine-tenths is hay. Yet hay making as an

effective or economic process of preservation depends upon the weather; grass can be cut for silage during a much wider period of the season and, when properly made and protected, silage can be stored without a weather risk to its final nutritional value. The average annual production of silage in Britain is 2½ million tons; Mr. Hamilton calls for at least 15 million tons. At a time when some £30 million more per year is being spent by Britain on imported animal feeding-stuffs, this can hardly pass unheeded. Research must develop better silage-making practices, with more mechanisation to aid the labour aspects and more attention to the influences that determine the quality of the ultimate product. Perhaps the most interesting suggestion was that some of the financial support now being given to British farming might be diverted from the deficiency payments scheme to a subsidy for silage-making. Economists and agricultural scientists will regard this as far less controversial than farmers.

Research spraying

MACHINERY for agricultural research is often produced by ' do-it-yourself ' methods, for the needs of investigation are commonly more delicate and graduated than the ultimate needs of farming. Spraying machines are one example. Field testing involves spraying a wide range of ' dosages ' whose actual differences are quite small. Making up the different solutions and emptying the sprayer for each plot is a cumbersome task, and in some experiments plot comparisons can be impaired by weather changes during the length of time required for treating all the plots. The ' do-it-yourself ' approach has resulted in the production of a new spraying machine for variable ' dosage ' applications in research. One filling with a base solution can provide continuously decreasing concentrations. The spray solution is withdrawn from an intermediate containing vessel and each withdrawal is followed by replacement with water from a second vessel. Dilution increases exponentially. An efficient agitator in the intermediate vessel ensures that the entering ' doses ' of water are speedily and uniformly mixed. This new piece of equipment has been fully described in *Nature* (**176,** 472, 1955), and it would seem to be a most useful British contribution to research technique.

French wheat surplus

THE termination of another good French harvest has again left a large surplus of wheat for disposal. A recent report from Paris indicates that it may not be easy to find buyers for this surplus, even though it will be offered at world prices and the difference made good by a State subsidy and a contribution from the growers. According to the *Financial Times*, 2,200,000 tons were exported over the last 12 months at a cost of £26 million to the Treasury and £14 million to the producers.

Under a trade agreement concluded with Germany last August, France will export 500,000 tons of wheat annually for three years, in addition to 200,000 tons of secondary cereals. This agreement, however, will do little to alleviate the position, for France is already exporting about as much wheat as Australia and Argentina and may rank third, after the U.S.A. and Canada, among world exporters.

As wheat exports are proving so expensive to finance, however, the French Government is attempting to reduce acreage by limiting the amount of harvest it will buy at the official price of 3,400 francs (£S3 8s. 0d.) per quintal (2 cwt.). This limitation was introduced 18 months ago by decree and it means that the farmer will get no guaranteed price on 8% of his wheat offering during the coming year.

The Government has decided, however, to maintain the official price, which was fixed. All wheat offered to the Government up to 6,800,000 tons is paid for at this price. The price for the balance will be fixed later on the basis of prices realised for it in foreign markets.

Grass exchange

IN 1954 FAO's Technical Assistance Programme extended for the first time to the remote islands of the South Seas, Fiji, the Solomon Isles, the New Hebrides and New Caledonia. On that occasion William Watson, a horticulturist and rice specialist, visited the area to advise on the possibilities of increasing rice production for local consumption. Now, A. T. Semple, range management specialist on FAO's regular staff, has joined a combined mission carrying out a survey on the grasslands of the region and their development possibilities. This survey is being made under the auspices of the South Pacific Commission,* by a joint team supplied by FAO, the Commonwealth Scientific Research Organisation of the Australian Government and the Commission itself. Among the countries visited are Papua (British New Guinea), Dutch New Guinea, New Caledonia and the Fiji Islands. When the tour of the area is completed, Semple will spend some time in Australia, investigating the possibilities of Australian grasses and forage plants with a view to their introduction in other parts of the world. This is a continuation of a close-knit interchange of personnel and ideas in this field, since several Australian grassland experts have already worked under FAO's auspices in areas such as the Mediterranean and Near East, where grasses and other plants suitable for introduction into their country have been found.

* The South Pacific Commission is a joint agency set up by the governments under whose control the territories of this region come: Australia, France, the Netherlands, New Zealand, United Kingdom and the United States of America.

Agricultural Progress in Canada—I

BASIS OF CANADIAN AGRICULTURE

C. H. GOULDEN

(Director, Experimental Farms Service, Canada Department of Agriculture)

Dr. Cyril Goulden, who is the Director of the Experimental Farms Service of the Canadian Department of Agriculture at Ottawa, has undertaken to act as Canadian Correspondent for WORLD CROPS. *Dr. Goulden will prepare the articles personally and represent Canadian agriculture to our readers in other countries in the light of the information available to his office. The Experimental Farms Service is the agency of the Canadian Department of Agriculture, which is responsible for all the experimental farm research in Canada and is closely in touch with all agricultural developments in relation to the very diverse types of farming in the various parts of Canada. We are fortunate indeed to retain Dr. Goulden's services.*

AGRICULTURE is the largest primary industry in Canada, and among all industries is second only to manufacturing in value of production. For the six-year period 1946–51 the average annual value of agricultural production was $1,935 million, as compared with $1,270 million for all other primary industries, $5,152 million for manufacturing and $9,317 million for all production. Of 4,032,000 male persons in Canada's labour force in 1951, 19.7% were employed in agriculture. Of Canadian exports in 1952, valued at $4,301 million, 29% were of Canadian farm origin. On a rough estimate, between one-third and one-half of Canada's population (15.6 millions in 1955) is dependent on agriculture for a livelihood.

Despite the importance of agriculture in the Canadian economy farming is restricted by climate and physiographic conditions to a relatively small proportion of the country, only about 4% of the total area (2,461 million acres) being under cultivation. The cold climate of northern regions precludes agriculture, nearly half of the country being described as 'arctic' and 'sub-arctic'. Most of Eastern Canada is occupied by the Canadian Shield (1,800,000 sq. miles) of practically soilless Precambrian rocks, and in the west the Cordilleran region (600,000 sq. miles) is largely mountainous. The principal agricultural regions lie in the St. Lawrence Lowland and Maritime areas south of the Canadian Shield in Eastern Canada, and in the southern part of the interior plain, which constitutes the 'prairie' region lying between the Shield and the Cordilleran. In the further description of Canadian agriculture these regions will be designated as Eastern Canada and the Prairie Provinces. Some reference will also be made to agriculture in the Cordilleran region of British Columbia, where the acreage of agricultural land is not great as compared to Eastern Canada and the Prairie Provinces, but where some very productive areas exist.

Eastern Canada

Eastern Canada, from Newfoundland to Ontario, extends over some 698 million acres, but only 3.4% of this area (23.9 million acres) was under cultivation in 1951. Lying on or near the Atlantic seaboard, this region enjoys a humid climate and an annual precipitation ranging from 67 in. in eastern Newfoundland to about 27 in. in the western parts of Ontario. Summers are warm, July mean temperatures ranging from 62–70° F.; but winters are generally cold, with January mean temperatures ranging from −1° F. in northerly districts to 28° F. in the warmest part of Ontario, and from 10° F. to 20° F. in most of the regions. In most districts snow blankets the frozen ground for several winter

Battery of self-propelled combines harvesting wheat from the swathe on the prairies, the source of 'Canada No. 1 Northern'

The rolling slopes that dip into the waters of the St. Lawrence have been the cradle of French Canadian life. Here a father and son use a reversible plough on the hills above Baie St. Paul, tilling the same soil that was first broken some 200 years ago by their forefathers

months, rendering winter housing of livestock necessary and preventing soil tillage and use of pastures. These climatic conditions are conducive to forest growth, to mixed farming, feed grains (oats and barley), hay and pasture occupying most of the arable land, with dairying as an important enterprise, and in favoured districts to special crops, including fruit and tobacco.

Prairie Provinces

The principal agro-climatic feature of the Prairie Provinces is the relatively light precipitation, the mean annual amount ranging from about 20 in. in eastern Manitoba to 11 in. in south-eastern Alberta. Fortunately, most of the precipitation is received during the summer season. July mean temperatures range from 60–69° F., similar to Eastern Canada, but winters are colder, January means ranging from 17° F. in the south-western part of the district to −10° F. in the north. Differences in precipitation and temperatures have combined to give this region its characteristic pattern of native vegetation; short-grass prairie in the warm, dry south central districts, through surrounding tall-grass prairie and park-land zones, to the fairly heavily forested land in the colder north. For the same climatic reasons, the region has proved mainly suitable for cereal culture, wheat, oats and barley being the principal crops. Throughout much of the Prairie Provinces summer fallowing for moisture conservation is a necessary measure to secure economic crop yields. Districts with submarginal soil and low rainfall are utilised mainly for cattle ranching. The total area of the Prairie Provinces is 452,159,000 acres, of which 71,840,000 acres, or 15.9%, are under cultivation.

TABLE 1

LAND USE IN CANADA BY MAJOR REGIONS
(From Census of Canada, 1951)

	Eastern Canada	*Prairie Provinces*	*British Columbia*	*Total*
Number of occupied farms ..	349,965	248,716	26,406	623,087
	1,000 acres	*1,000 acres*	*1,000 acres*	*1,000 acres*
Total area in farms	45,491	123,853	4,702	174,046
Improved farmland	23,865	71,840	1,147	96,852
Land under grain production ..	6,327	43,025	282	49,634
Summer fallow, mostly for grain production	392	21,570	70	22,032
Land under wheat	808	24,832	106	25,746
Hay and cultivated pasture ..	14,588	5,316	654	20,558
Hoed crops, orchards and gardens	1,674	193	76	1,943
Other crops	884	1,736	65	2,685
Estimate of rough pasture ..	7,000	43,000	2,000	52,000

British Columbia

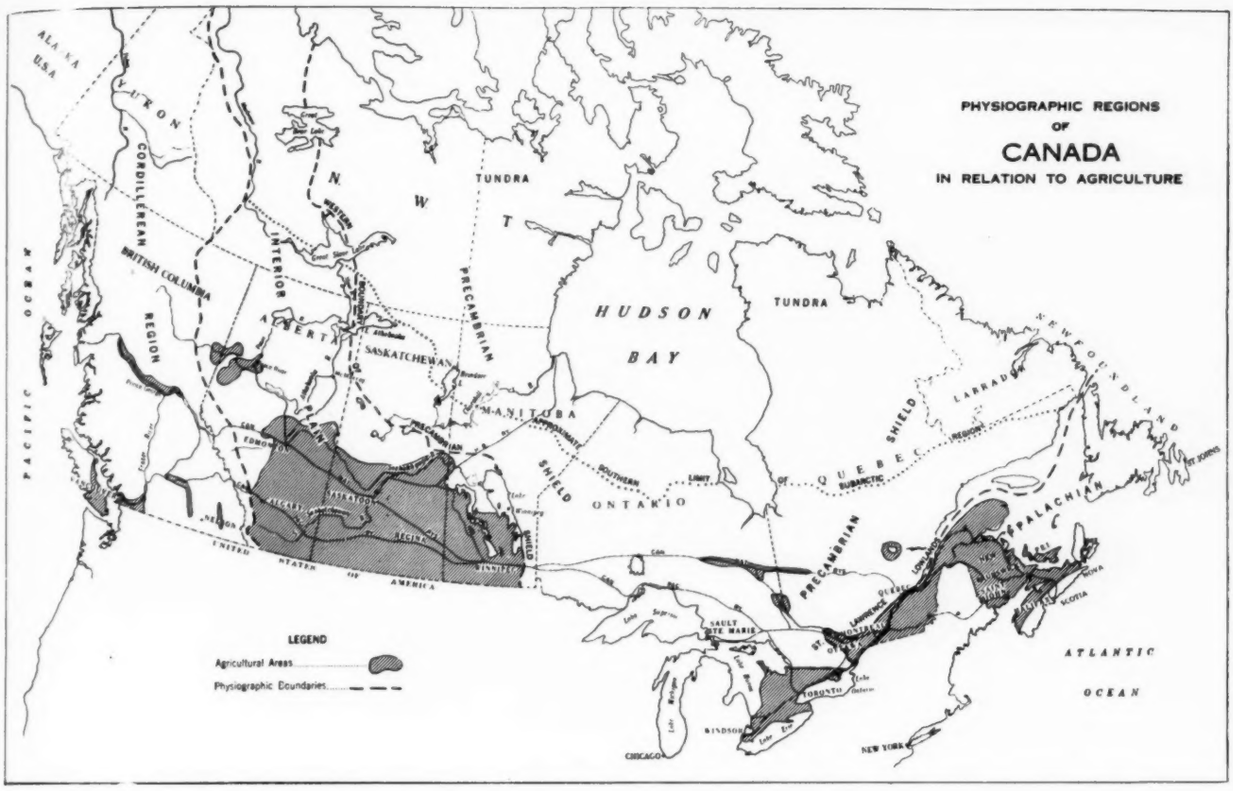
Mountainous terrain renders most of British Columbia unsuitable for farming, only about one-half of 1% of its total area of 229,940,000 acres being under cultivation. A succession of south-to-north mountain ranges, from the Coast Range on the Pacific to the Rockies on the eastern boundary, results in marked climatic differences within the province. Atmospheric moisture from the Pacific is deposited in diminishing degree on successive ranges as the air moves inland, with a corresponding decline in mean annual precipitation from over 60 in. on the coast to about 11 in. in the interior. In the southern part of the province July and January mean temperatures range from 36–62° F. respectively at Victoria to 13–59° F. at Prince George. The main types of farming are dairying in the Fraser River valley, irrigated fruit production in the dry south-west, and cattle ranching on the interior plateaux.

Some indication of the pattern of land use in the foregoing regions is given in Table 1.

The large percentage of cultivated land used for grain production in Canada, and particularly in the Prairie Provinces, is indicated in Table 1. The combined acreage in 1951 of grain and summer fallow, the latter used mainly for wheat production, was 71,660,000 acres for all Canada and 64,595,000 acres in the Prairie Provinces, accounting for 74% of all improved land in Canada and for 90% in the Prairie Provinces. By contrast hay and cultivated pasture account for 61% of the improved land in Eastern Canada, as compared with slightly over 7% in the prairie region, where most of the grazing is on rough, uncultivated pasture. Types of farming in British Columbia show somewhat the same proportions as in Eastern Canada.

Livestock

As indicated in Table 2, cattle kept



for milk production predominate in Eastern Canada, and beef cattle in the prairie region. Of cows kept for milk in 1951, 69.5% were in the east and 27.6% in the Prairie Provinces, the corresponding proportion for beef cows being 22.9% and 70.3% respectively. Eastern Canada had 62.3% of all swine. Relatively few sheep are raised in Canada.

The number of horses on farms in Canada, 1,307,000 in 1951, has declined in recent years with the advent of the tractor. In 1921 there were 3,452,000 horses on Canadian farms. In the 30 years from 1921 to 1951, farm tractors increased in number from 47,000 to 400,000 and to 475,000 in 1955.

One important feature of Canadian agriculture is its comparative newness, nearly 80% of the present crop acreage having come under cultivation since 1881. Early development, beginning at Quebec about 1623, was a slow process of clearing forested land for crop production. By 1881 this was nearing its present level in Eastern Canada, with 21,402,000 acres of improved land (23,865,000 acres in 1951), but the prairie region, with only 279,000 acres under cultivation, was largely untouched. After 1885, when completion of the first transcontinental railway made the easily broken prairie readily accessible for settlement, cultivation in the Prairie Provinces increased at a rapid rate, acreages of improved farmland reaching 24,281,000 acres by 1911, 59,819,000 acres by 1931, and 71,660,000 acres by 1951. In 1953 the Prairie Provinces produced approximately 584 million bushels of wheat, 276 million bushels of oats and 251 million bushels of barley, or 95%, 68% and 96% respectively of the total production of these crops in Canada. In 1880 96% of the wheat, 98% of the oats and 98% of the barley produced in Canada was grown east of the province of Manitoba.

Important Historical Developments

During the period of agricultural development, brief as compared with Old World history, means and methods of farming in Canada have undergone repeated adaptations and adjustments, originally through trial and error, but assisted in later years by scientific research. Early crop production was largely of a subsistence nature, and it was not until about 1890 that exports of wheat from Canada consistently exceeded imports. Crop varieties, largely of European origin, were in many cases unsuitable for Canadian culture, particularly with wheat. About 1840 a farmer of Peterborough, Ontario, David Fife, selected one head of wheat from a small plot which he had sown with seed of unknown origin received from Scotland. This selection, a hard, red, spring variety, proved more suitable than other available varieties for Canadian conditions and under the

TABLE 2
NUMBERS OF LIVESTOCK IN CANADA BY REGIONS, 1951

Principal kinds of livestock	*Eastern Canada*	*Prairie Provinces*	*British Columbia*	*Total*
	Thousands	*Thousands*	*Thousands*	*Thousands*
All cattle	4,541	3,509	321	8,371
Milk cows, two years and over	2,022	803	83	2,908
Beef cows, two years and over	255	784	76	1,115
Swine	3,065	1,802	49	4,916
Sheep	879	532	67	1,478
Horses on farms	575	696	36	1,307

name of Red Fife was widely used in Canada and the northern parts of the U.S.A. In general, however, there was little sustained effort in Canada for the improvement of agriculture, whether in crop varieties, livestock breeds or soil management, before 1886.

Experimental farms

In 1886 the Canadian Government, recognising the need for the application of scientific methods to agriculture, established experimental farms at five points across the country and subsequently at other points where their need became evident. At the present time (1955) the work of the experimental farms is conducted by nearly 500 trained agriculturists on an extensive system of farms and laboratories, in contact on the one hand with scientific agencies and universities and on the other with practical farmers, and embraces all major fields of research relating to practical agriculture.

Suitable wheat varieties

One of the first problems investigated by the experimental farms was the need for suitable crop varieties, particularly as regards wheat for the newly opened prairie region. Possibly the most outstanding success in this work was the creation of Marquis wheat. This variety, resulting from a cross made in 1892 between Red Fife and an Indian variety, Hard Red Calcutta, is a hard, red, spring wheat of excellent bread-making quality, which for many years was the principal variety grown in Western Canada and is still the ' yardstick of quality ' in wheat-breeding work. In 1920 it was estimated that Marquis was sown on 90% of the 17,000,000 acres then under wheat in the Prairie Provinces. Subsequently, with the spread northwards into Western Canada of wheat-stem rust, to which Marquis proved susceptible, this variety has been largely superseded by newer disease-resistant varieties. It is interesting to note, however, that Marquis, and therefore Red Fife, is found in the ancestry of most of the hard spring wheats now in use.

Recent developments will be reviewed in Part II of this article.

Photos: p. 428, The National Film Board of Canada; p. 427, Information Service, Canadian Department of Agriculture, Ottawa.

Colorado Beetle

The Ministry of Agriculture, Fisheries and Food announces the successful completion of the 1955 Colorado beetle precautionary spraying campaign, one of the measures undertaken to prevent the beetle establishing itself in this country.

This year's spraying programme, which covered a somewhat smaller area than last year, has been carried out according to plan. Approximately 14,700 acres of potatoes in Kent and Essex, areas thought to be the most vulnerable and where outbreaks have occurred in the past, have been sprayed by ground machines or helicopter during the period 13 June to 6 August. The Minister wishes to acknowledge once again the co-operation and assistance received from all concerned, including the firms who undertook the work, the National Farmers' Union and, above all, the farmers themselves.

Dorman Sprayers

The Sales Office of the Dorman Sprayer Co. Ltd. has been moved to Ditton Walk, Cambridge, England.

Indian Prince sees British Machinery

His Highness the Nawab of Bhopal, Central India, recently visited Sir Francis Whitmore's Orsett estate, in Essex.

A demonstration, arranged by the Agricultural Engineers' Association, was held at His Highness's request. Among the machines demonstrated were the Ransome MG6 tractor with Howard Rotavator, the International BWD6 tractor with 60-in. ' E '-type three-point linkage Howard Rotavator, and the Howard Rovatators ' Gem ' and ' Yeoman '.

His Highness is spending a short time in England looking for suitable implements and equipment to suit conditions in Bhopal. Bhopal is a country of 7,000 sq. miles, with a population of over 780,000.

From questions he asked the demonstrators, it is evident that His Highness's knowledge of modern agriculture is wide and varied.

The Nawab of Bhopal (second from left) watching a Howard Rotovator 'Gem' working on an estate in Essex belonging to Sir Frances Whitmore, Lord Lieutenant of Essex. On the left is Mr. T. Barraclough, Export Sales Manager of Rotary Hoes Limited, and next to the Nawab Mr. S. F. Ali, His Highness's Private Secretary, and Mr. E. N. Griffith, Chairman of Rotary Hoes Limited

[Photo : Rotary Hoes Limited]

PHOSPHORUS FERTILISERS FOR PLANTATION CROPS

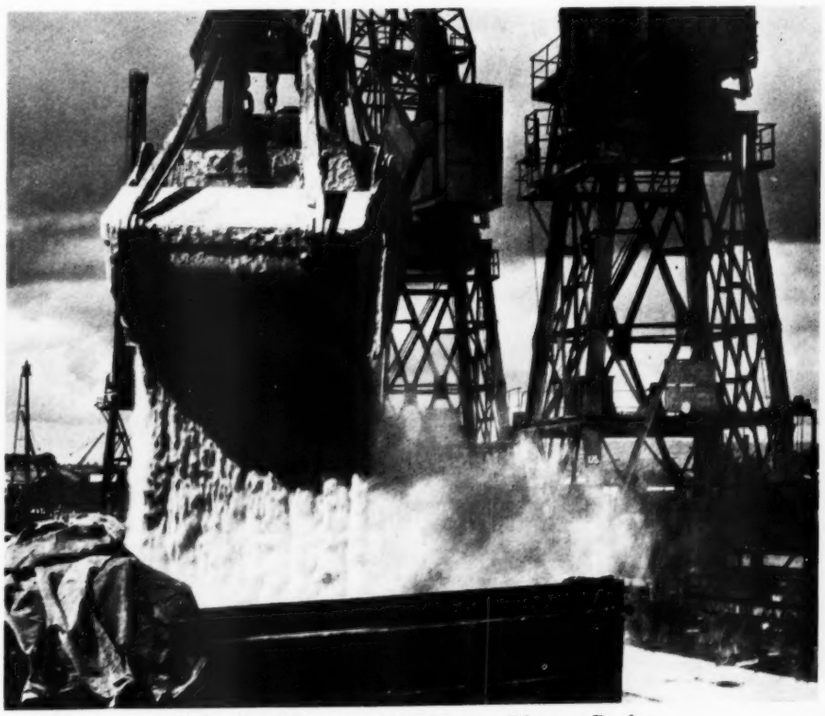
D. J. HALLIDAY AND J. B. SYLVESTER
(Jealott's Hill Research Station, Bracknell, Berks.)

The use of bones, fish and dung of birds as fertilisers is an ancient agricultural practice, dating back at least 2,000 years. Not until the end of the 18th century, however, was it realised that the manurial value of these materials lay in the phosphorus they contained—phosphorus, the 'light-bearer', discovered and named by Hennig Brandt in 1669 after the way it glowed in the dark, and later identified as an element by Antoine Lavoisier. In 1842, a memorable date in agricultural history, John Bennett Lawes, the founder of Rothamsted Experimental Station, and Sir James Murray, of Dublin, were granted patents for 'chemically decomposing, for purposes of manure, by means of sulphuric acid, bones, bone-ash or bone dust or apatite or phosphorite or any other substance containing phosphoric acid'. Lawes later bought out Murray and amended his patent to cover only mineral phosphates as he could not claim novelty for the treatment of bones. Thus began the world's inorganic fertiliser industry.

THE principal phosphorus fertilisers used today are superphosphate, basic slag, rock phosphate and ammonium phosphate. Bone products and guano are still widely used. Before the 1939–45 war, world output of phosphate rock was estimated at 13 million tons, of which 35% was produced in North Africa, 30% in the U.S.A., 18% in the U.S.S.R. and 10% in the Commonwealth territories of Nauru and Ocean Island, in the Pacific, and Christmas Island, off Singapore. Since the war output has risen to 21½ million tons (excluding the U.S.S.R., for which no reliable figures are available), and, of this, the U.S.A. contributes no less than 11 million tons. Two main types of deposit are distinguished: firstly, the crystalline apatites, which occur chiefly as veins or intrusions in igneous rocks, notably in the Kola Peninsula in the U.S.S.R.; and secondly, the amorphous sedimentary deposits known as phosphorite, usually of marine origin and formed from the decomposition either of phosphatic limestones or of animal remains, examples of which occur in Florida, Tennessee and the western U.S.A., and in French Morocco, Algeria, Tunisia, Egypt and the Pacific Islands. (See Table 1.)

Apart from the nature of the deposit and the amount of phosphorus it contains, the quality of phosphate rock depends also upon its content of iron and aluminium oxides and of fluorine, all of which tend to reduce its availability to plants and may require special processes for their removal during the preparation of manufactured fertilisers. The seller usually guarantees that the iron and aluminium oxides do not exceed a certain figure, which may vary from 0.5 to 3% or more. The fluorine content, too, usually lies between these limits.

It is estimated that some 80% of all phosphate rock output goes into superphosphate. This fertiliser is still made, as in Lawes's day, by treating ground phosphate rock with sulphuric acid, but modern methods and accurate mechanical mixing ensure a uniform product in far better physical condition than was obtainable a hundred years ago. The present product usually contains about 18% of water-soluble P_2O_5. A higher grade, termed triple superphosphate (sometimes known as 'double' or 'concentrated' superphosphate), is made by treating phos-



Unloading Moroccan phosphate at Glasgow Docks

phate rock with phosphoric, instead of sulphuric acid, and may contain nearly 50% of P_2O_5. Another variant recently developed in the United Kingdom, though not at present commercially produced there, is obtained by substituting nitric acid for sulphuric acid; the resulting product, after removal of calcium nitrate by treatment with ammonia and ammonium sulphate, being known as nitrophosphate. A typical analysis is 13.8% N and 13.8% total P_2O_5 (13% soluble in 2% citric acid and 4.5% soluble in water). Alternative processes have been developed in France, the Netherlands and the U.S.A. Yet another variant, dicalcium phosphate, containing about 40% of P_2O_5 soluble in neutral ammonium citrate solution, is manufactured in certain parts of the world by treating phosphate rock with hydrochloric acid, obtained as a by-product in the preparation of sulphate of potash, and then precipitating the dissolved phosphate.

After superphosphate, the second most important phosphorus fertiliser is basic slag, a by-product in the manufacture of steel from pig iron by the Bessemer (Gilchrist-Thomas) process or by the open-hearth process. In both cases phosphorus, which occurs as phosphide impurity in pig iron, is removed by oxidation at a high temperature in the presence of lime or other basic materials having a strong affinity for the resultant P_2O_5. In the former process, which in many countries has been superseded, a current of air is blown through the molten mass and the high temperature required is obtained from the combustion of silicon, carbon and phosphorus contained in the metal; an ore rich in phosphorus is therefore desirable. In the latter process, the heat required is largely derived from an outside source and the presence of phosphorus is not only unnecessary, but undesirable; moreover, the employment of fluorspar as a flux may convert whatever phosphorus is present into an insoluble form. Thus we may differentiate: (1) highly soluble, high-grade Bessemer slags containing perhaps 18% total P_2O_5 and 15–16% of P_2O_5 soluble in 2% citric acid (*i.e.* nearly nine-tenths of the total P_2O_5 is citric acid-soluble); (2) highly soluble, low- or medium-grade open-hearth slags containing, say, 8–10% total P_2O_5, of which over four-fifths may be citric acid-soluble; and (3) sparingly soluble, low- or medium-grade open-hearth slags containing the same total amount of P_2O_5, but of which, owing to treatment with fluorspar, less than two-fifths is citric acid-soluble. As well as phosphorus, basic slags contain 40–50% of CaO in various combined forms and it is usually reckoned as a rough guide that their liming value is equal to about two-thirds of their weight in chalk or limestone.

TABLE I

COMPOSITION OF PHOSPHATE ROCK: TYPICAL ANALYSES*

	P_2O_5, %
Kola apatite	30.1
Morocco (Khouribga) ..	35.1
,, Safi (Louis Gentil)	31.9
Algeria, Constantine ..	30.6
Tunisia, Gafsa	27.6–30.6
Egypt, Safaga	31.0
,, Kosseir	30.6
Idaho, Utah, etc. (high-grade)	27.0–36.5
Florida, land pebble ..	30.0–34.0
,, hard rock ..	36.4
,, soft	25.0–27.0
Tennessee, brown	30.0–38.0
,, blue	27.0–32.0
Nauru	38.9
Ocean Island	40.3
Christmas Island	39.5
Curacao	35.7–40.7

*From Gray, A. N., 'Phosphates and Superphosphate', 2nd edn., 1944; and Waggaman, W. H., 'Phosphoric Acid, Phosphates and Phosphatic Fertiliser', 2nd edn., 1952.

Of the total world production of phosphate rock, it is estimated that some 10% is finely ground for direct application to the soil as a fertiliser. Its effectiveness varies greatly with the source of the material, fineness of grinding, crop, soil, climate etc. Care should be taken in purchasing as some kinds appear to be completely valueless for direct use.

Mono-ammonium phosphate, containing in its pure state 61.7% of water-soluble P_2O_5 and 12.2% of N, and commercially about 50–54% of P_2O_5 and 12% of N, is an important ingredient of concentrated compound fertilisers. It is made either by treating phosphate rock with sulphuric acid and ammonium sulphate or by treating phosphoric acid with ammonia. Di-ammonium phosphate, containing in its pure state 53.4% of P_2O_5 and 21.1% of N, is also used as an ingredient of concentrated fertilisers. Ammoniated superphosphate is prepared by treating ordinary superphosphate with aqueous or anhydrous ammonia or with ammoniacal solutions containing ammonium nitrate or urea; up to 3% of ammonia on the weight of superphosphate may be added without appreciably reducing phosphorus 'availability', as determined by solubility in 2% citric acid or neutral ammonium citrate solution; triple superphosphate and ordinary compound fertilisers may be treated in the same way. Other phosphorus fertilisers are obtained by calcining or fusing phosphate rock with materials such as lime, silica and soda ash. Examples are Rhenania phosphate (25–30% of P_2O_5), silico phosphate (20–35% of P_2O_5), calcium magnesium phosphate (about 22% of P_2O_5), fused tricalcium phosphate (26–30% of P_2O_5) and defluorinated phosphate rock (about 20% of P_2O_5). About nine-tenths of the phosphorus in these fertilisers is soluble in 2% citric acid. Fused calcium metaphosphate (about 64% of P_2O_5) is produced at a somewhat lower temperature (1,000–1,200° C.) by treating phosphate rock with phosphorus pentoxide. Nearly all the phosphorus in this fertiliser is soluble in neutral ammonium citrate solution, but less than one-quarter in 2% citric acid.

The principal bone products available as fertilisers are bone meal and steamed bone flour. They are both slow-acting. The former contains 3–4% of N and 20–24% of P_2O_5 and is obtained by grinding bones from which the fat has been extracted for sale as tallow or for use in soap-making. Steamed bone flour contains about 27% of P_2O_5, but only 1% of N, and is obtained as a by-product of gelatine and glue manufacture after steaming bones at high pressure; owing to the removal of the cartilage, it can be ground to a much finer powder than bone meal. Raw bones contain some 7–10% of P_2O_5, and bone ash 30–40% of P_2O_5.

The term 'guano' strictly relates to the sun-dried excreta of sea birds, but it has been extended to include the excreta of bats and also, under the names 'fish guano' and 'meat guano', dried and ground fish and slaughter-house wastes. The true guano may contain anything from 9 to as much as 30% of P_2O_5, and fish and meat guano from 1 to 14% of P_2O_5, as well as nitrogen.

Evaluation of phosphorus fertilisers

In the foregoing paragraphs the phosphorus content of fertilisers has been expressed variously in terms of total, water-soluble, citric acid-soluble and citrate-soluble P_2O_5. Elsewhere the phosphorus content may be expressed in terms of the element P or tricalcium phosphate, $Ca_3(PO_4)_2$ (tribasic phosphate of lime). The appropriate conversion factors are:

To convert P to P_2O_5, multiply by 2.289.

To convert P_2O_5 to P, multiply by 0.437.

To convert $Ca_3(PO_4)_2$ to P_2O_5, multiply by 0.458.

To convert P_2O_5 to $Ca_3(PO_4)_2$, multiply by 2.185.

The solubility is given as a rough indication of the ' availability ' of the phosphorus to plants and, when officially declared by the manufacturer, provides the purchaser with a guarantee of quality. In general, water-solubility indicates phosphorus that is readily available to plants; solubility in 2% citric acid or in neutral ammonium citrate solution indicates phosphorus that is moderately available to planst,

TABLE 2
PHOSPHORUS UPTAKE BY CERTAIN ANNUAL CROPS (ASSUMING AVERAGE YIELDS)

Crop	*P_2O_5 uptake, lb./acre*
Wheat	20
Barley	23
Oats	25
Maize	35
Rice	20
Peas	35
Beans	40
Sugar beet	50
Carrots	40
Potatoes	50
Tomatoes	25
Cabbages	65

or, perhaps, under certain conditions, just as readily available as phosphorus in the water-soluble form; and insolubility in any of these solvents, phosphorus that may be only very slowly available to plants. These are necessarily generalisations, as phosphorus in one form may be available to one plant species and not to another, whereas mixture with the soil may rapidly change a soluble into an insoluble form. Nevertheless, they do give a quick method of estimating the relative merits of different fertilisers

Wattle (18 months old) growing on the Wattle Research Institute's Field Experiment Station (' Bloemendal ') near Pietermaritzburg. The trees on the left received a dressing of superphosphate at the rate of 400 lb. per acre, applied in bands on each side of the tree rows at the first thinning, i.e. at two to three months; those on the right of the figure had no fertiliser

and provide a ready means of making cost comparisons, the water-soluble phosphorus in superphosphate fetching perhaps double the price of insoluble phosphorus in phosphate rock, with citric acid-soluble phosphorus in basic slag occupying an intermediate position.

Uptake of phosphorus by plants

Phosphorus is of major importance to plants throughout their growth. It is a constituent of nucleic acid, which occurs in all living cells. Compounds of phosphorus are concerned with the processes of respiration and with the efficient functioning and utilisation of nitrogen. It is also of special significance in root development and the ripening of seeds and fruits. Characteristic symptoms of phosphorus deficiency include stunted growth, delayed ripening, poor fruiting, poor root growth and dull bluish-green leaf colour with purple tinting. Fruit from phosphorus-deficient plants is usually rather soft and acid in flavour and its keeping quality poor. The amount of phosphorus taken up by healthy annual crop plants is indicated in Table 2. The gross uptake and net annual removal in the harvested portion of certain plantation crops is indicated in Table 3. In general, the uptake of P_2O_5 is appreciably smaller than that of N or K_2O, lying between one-fifth and one-half of those amounts.

With plantation crops the total amount taken up will be considerably greater than the amount removed in

TABLE 3
PHOSPHORUS TAKEN UP AND REMOVED ANNUALLY IN PRODUCE FROM CERTAIN PLANTATION CROPS

Crop	*Gross P_2O_5 uptake, lb./acre*	*P_2O_5 removed, lb./acre*	*Portion taken into account*
Bananas	55	30	Fruit, one-third of stalk and leaves
Coconuts	—	30	Nuts, leaves and inflorescences
Coffee	40	10	Leaves and cherries
Sugar cane	65	50	Millable cane and green tops
Tea	—	12	Plucked shoots

the harvested portion and the actual net removal will depend upon management and how much waste is returned to the soil. The roots, trunk and branches of a rubber tree, for example, will contain very much more phosphorus than is present in the latex; of some 40 lb. or more of P_2O_5 per acre taken up each year, not much more than 1 lb. will be removed in the latex and, although part of the remainder may go back to the soil when the leaves fall, the rest will not return until trees die and the trunks and branches rot (if they are sold for firewood it never will return!).

Principles of phosphorus manuring

The figures given above relate to phosphorus *uptake* by the plant and *removal* in produce. In estimating fertiliser *requirements* several other factors must be taken into account. Firstly, the mineral constituents of plants, including phosphorus, are not derived solely from fertilisers, which merely supplement the soil's resources. Secondly, as has already been mentioned, the interaction between fertiliser and soil (particularly acid soils and those that are rich in iron or aluminium) may reduce the availability of fertiliser phosphorus to the plant. In practice, the efficiency of phosphorus fertilisers, as measured by the proportion of fertiliser phosphorus that finds its way into the plant in the first season or two, is seldom more than 10–20%. In other words, to replace every 1 lb. of P_2O_5 removed in the crop it is necessary to apply at least 5 lb. of P_2O_5 in fertilisers. If the phosphorus is needed quickly and the soil is not one that 'fixes' applied phosphorus too rapidly, then fertilisers with a high degree of water-solubility, such as superphosphate or mono-ammonium phosphate, may be used. If the phosphorus requirement is spread over a long period or conditions are such that there is no particular advantage in using water-soluble fertilisers, then the less soluble materials, such as basic slag, ground rock phosphate or bone products, may be more profitable. Some economy in fertiliser usage may be achieved by placement of the fertiliser in bands, drills or manure circles exactly where it is needed instead of spreading it broadcast; by using granular instead of powdered materials, so as to minimise 'fixation' by reducing the surface area that comes into contact with the soil (this does not apply, of course, to fertilisers like bones and ground rock phosphate that are already insoluble); and by giving smaller dressings of fertiliser every one or two years instead of larger dressings every four or five years. There is some evidence that continued applications may have residual effects that last over many years.

Phosphorus manuring of plantation crops

It is appropriate here to instance results produced by phosphorus fertilisers on coconuts in Ceylon. The main experiment of the Ceylon Coconut Research Institute, at Bandiripuwa Estate, has been carried out on an area containing adequate reserves of phosphorus and in no year has the application of 1 or 2 lb. of P_2O_5 per palm given a response. The experiments at Veyangoda and Ahangama, on the other hand, are sited on soils with low reserves of plant food. Under these conditions the application of only 0.6 lb. of P_2O_5 (*i.e.* 2 lb. of rock phosphate) per palm every other year has given dramatic results. Table 4 shows the increase in copra obtained each year up to 1945–46 (when the treatments were changed).

TABLE 4
COCONUT EXPERIMENTS: YIELDS OF COPRA (lb./acre)

Year	*Complete fertiliser*	*Without phosphate*	*Difference for applying phosphate*
1939–40	553	490	63
1940–41	627	562	65
1941–42	998	809	189
1942–43	1,073	744	329
1943–44	1,096	774	322
1944–45	1,287	828	459
1945–46	1,115	763	352

As a result of these experiments, the following applications are recommended for bearing palms, once in every two years: on loams, sandy loams and clay soils, 0.6 lb. of P_2O_5 per palm; and on laterites, lateritic gravel and white cinnamon and coarse marine sands, 0.75 lb. of P_2O_5 per palm. For young palms, an annual application, rising from 0.15 lb. of P_2O_5 in the second or third year after planting to 0.35 lb. of P_2O_5 in the fifth year and thereafter until flowering, is advised. In every case these should be balanced by appropriate dressings of potash and nitrogen.

In the experiments of the Ceylon Tea Research Institute, tea has shown a substantial response to annual dressings of up to 30 lb. of P_2O_5 per acre. For ordinary conditions an annual application of 20–30 lb. of P_2O_5 is recommended, together with a similar amount of potash and up to 80 lb. of nitrogen per acre, depending upon economic circumstances and the cultural state of the tea bushes.

For rubber, the Rubber Research Institute of Ceylon recommends an annual dressing rising from 0.1 lb. of P_2O_5 per tree in the first year and 0.25 lb. of P_2O_5 in the second year to 0.5 lb. of P_2O_5 in the seventh and subsequent years, accompanied by nitrogen and potash in the ratio $N : P_2O_5 : K_2O = 4 : 6 : 5$.

This article is reprinted from the *Ceylon Coconut Quarterly* with the permission of F. C. Cooke, ESQ., E.D., A.R.C.S., B.SC., A.M.I.CHEM.E., Director, Coconut Research Institute of Ceylon.

Technical News

Paint Manufacture for November contains articles on 'The Evaluation of Aluminium Pigments' by G. M. Babcock and F. B. Rethwisch; 'Use Your Plant Efficiently—II' by G. Scott; and 'Problems of Paint Manufacture—II' by L. A. Sonsthagen.

The November issue of *Manufacturing Chemist* includes 'Medicinal Products from Tropical Plants' by Prof. C. H. Hassall; 'Vanillin' by F. Schmitt; and summaries of papers read at the International Pharmaceutical Conference (London, 12–23 September, 1955).

The enlarged issue of *Dairy Engineering* for November will contain a full illustrated preview of exhibits at the 69th Annual Dairy Show.

Among the articles appearing in the November issue of *Chemical & Process Engineering* are 'Ozone—II' by D. J. Saxby, B.SC., F.R.I.C.; and 'Production and Costs in Australia's Sulphuric Acid Industry'.

Food Manufacture for November includes 'Garden Peas from a Midland Factory'; 'The Dehydration of Carrots', by E. G. B. Gooding and C. G. Tucker; and 'Food Technology at American Chemical Society Meeting'.

USE OF ACTIVATED SLUDGE AS A FERTILISER

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During recent years there has been considerable publicity about a new arrival in the field of fertilisers—activated sludge. For many years low-grade sludges have been on the market, with a nitrogen content less than 1% and a moisture content as high as 35–40%. Therefore the production of an activated sludge having a nitrogen content of 6½%, a phosphoric acid content of 5½% and a moisture content of 5½% is to be welcomed. This material, produced at the Colne Valley Sewerage Board works in Hertfordshire, will be of great benefit to many growers requiring an effective organic manure of high analysis yet cheap in price.

THE use of activated sludge as a fertiliser is quite new in England. In fact, it is only during the last few years that it has been produced. At Rickmansworth, Hertfordshire, the Colne Valley Sewerage Board have built what is probably the largest complete plant outside of U.S.A., and certainly the only one in Great Britain producing an activated sludge, biologically produced, in a dry and sterilised form. Visitors to this plant are welcomed and arrive in hundreds every year from all parts of the world.

From the outset it should be explained that the name of activated sludge is a misnomer, as it is not a sludge, although the product of a sewerage works. Nevertheless, to distinguish it from the products normally known as sludges it will be described as such.

Conceived in the early thirties, the first contracts for the construction of the scheme were let in September 1938, but, owing to the war, work had to be closed down in 1940. Construction was restarted in May 1946 and the first flow of sewage received in May 1951. Since then construction has continued, but is as yet not completed. However, the flow now received and treated amounts to 10 million gal. a day. The area served is approximately 150 sq. miles, with a population of 350,000. The population is increasing rapidly and it is expected that it will increase to 550,000. Existing local sewage works (26) have been closed down and incorporated in the scheme. This includes that of the Borough of Watford.

The aerial photograph of the works was taken in June 1952 (see accompanying figure). Further sedimentation tanks, aeration channels, final settlement tanks etc., are now under construction and will soon be in operation.

Both activated and digested sludges are produced and the original idea was to dry them in order that they may be used as fuel to create the heat to dry subsequent production. In this way a complete sewage disposal could be effected and, as there are several old quarries in the neighbourhood, the ashes produced could be very easily deposited and the workings filled in. Both kinds of sludge burn well; the activated, owing to its microbial construction, has a high carbon : nitrogen ratio and a calorific value of over 50% that of coal.

However, from the very early stages it was considered that the high nitrogen content would make the activated sludge a valuable fertiliser.

The final material after processing is twice washed to remove any chemicals etc., which may be of harm. The very troublesome oils are reduced to a minute fraction and from an agricultural point of view there is nothing whatever of a toxic nature remaining in either the activated or digested products.

TABLE 1

Pure activated dried sludge:	
Moisture, %	5.4
On a dry basis:	
Organic matter and combined water, %	68.9
Ash, %	31.1
Total nitrogen, % ..	7.01
Nitrate nitrogen, % ..	0.21
Total phosphoric acid (P_2O_5), %	6.10
P_2O_5 soluble in 2% citric acid soln., %	1.40
Potash (K_2O), % ..	0.82
Manganese, Mn, % ..	0.067
Magnesium, Mg, % ..	0.45
Copper, Cu, % ..	0.027
Chromium, Cr, % ..	0.099
Zinc, Zn, %	0.128
pH value (water extraction)	6.5

Composition

This product has a very high true organic content, containing as it does the protein, carbohydrate etc. of the bacteria in addition to their valuable mineral structure. A typical analysis is shown in Table 1.

From this analysis it is very obvious that it cannot be compared with the ordinary sludges, where the nitrogen content may not even exceed 1%. Also it has a high phosphoric acid content and an abundance of valuable 'trace' elements. The digested dried sludge has a nitrogen content of 3% and phosphoric acid content of 2%. By using these two products as produced or mixing in the cakes stage and then drying together, a wide variety of analyses could be produced, but for practical reasons a mixture with 4.5% nitrogen has been produced.

Availability as plant food

It has been widely thought that the value of sludges was confined to their organic content and consequent ability to improve soil structure. Some critics have maintained that the bacterial activity in the soil, subsequent to an application, would rob the soil of its available nitrogen and as a result cause a temporary nitrogen starvation condition. In some tests where large quantities have been applied this has actually happened. Also in some districts the industrial effluents contain toxic matter which is not removed in the processing. These in use have caused various kinds of soil ' sickness '. Many tests were consequently undertaken to clarify the effects of the nitrogen etc. of the products of the Colne Valley plant. An early experiment was made to compare the nitrogen conversion to nitrate in the activated sludge with that of dried blood. By using the same weight of nitrogen, quantities of activated sludge and dried blood were mixed with the local loam soil and the test conducted according to those done by Hamence *et al.*

Daily tests were made to determine the rate of breakdown to nitrates. Results are shown in Table 2.

TABLE 2

Day	4	10	14
Dried blood, %	7.2	32.1	39.7
Activated sludge, % ..	6.8	15.5	17.8
% A.S. to D.B.	95	48	47

It will be noted that during the first few days the rate of breakdown was practically the same, but after a week or so the rate settled down to just under 50%. Nevertheless, breakdown was at a rate consistent with plant requirements, with the added advantage of maintaining the organic content of the soil over a longer period. If the breakdown is too rapid, a soft green growth results and rain or watering may leach out the soluble nitrates, so that the beneficial effect of an application is only temporary. Most growers have experienced this. Later cropping experiments proved that activated sludge gave better results per unit of nitrogen over the full growing period than either dried blood or hoof and horn meal.

Intensive tests were undertaken to discover its composting ability. Controls were stable manure or dried blood, or both, and the crops selected were those normally grown on a compost—cucumbers and mushrooms. For the cucumber crop a compost was made from 3 cwt. of activated sludge, 1 ton of wheat straw (dry wt.) and about 3 tons of water. The resulting mixture composted well; a temperature of 160° F. was reached after six days in the pile. After one turn it was placed in the glasshouse and beds made up in the usual manner. A compost of a heavy stable manure was made up and cropping records kept in three houses and with different varieties. The variations were slight, but in favour of the composts made up with activated sludge. At the same place the grower purchased a manure turner in order that composting could be done more efficiently. The procedure was to soak the straw for about six to seven days in order to break down as far as possible the shininess of the wheat straw and to make it more absorbent. It was then stacked, mixing the activated sludge at the same rate of 3 cwt. to the ton of wheat straw, layering the activator. Two turns were given, temperatures of 165° and 150° F. being reached. These tests were done on a large scale—3 acres of glasshouses. The control was the normal method of growing, using stable manure with dried blood as a top dressing. The crops from the compost using activated sludge actually showed an increase of 27½% over the control and averaged just under two flats per running foot of house. The quality was better, this including colour, weight and shipping quality. An analysis of cucumber beds after two months of cropping gave the results shown in Table 3.

These show very little difference.

By using a different method of composting based on the Sinden-Hauser method of turning every other day and completing composting in eight days very interesting results were found. In this case the official activator formula of the Mushroom Research Association (M.R.A.) was used. This formula uses dried blood for 75% of its bulk, the balance being made up of gypsum, limestone, superphosphate, sulphate of potash and trace elements. The blood portion was replaced with activated sludge on a nitrogen content basis. The comparative analyses at the end of the composting are shown in Table 4.

There was an ammonia loss with the dried blood, but, despite the very quick breakdown, none with the activated sludge compost.

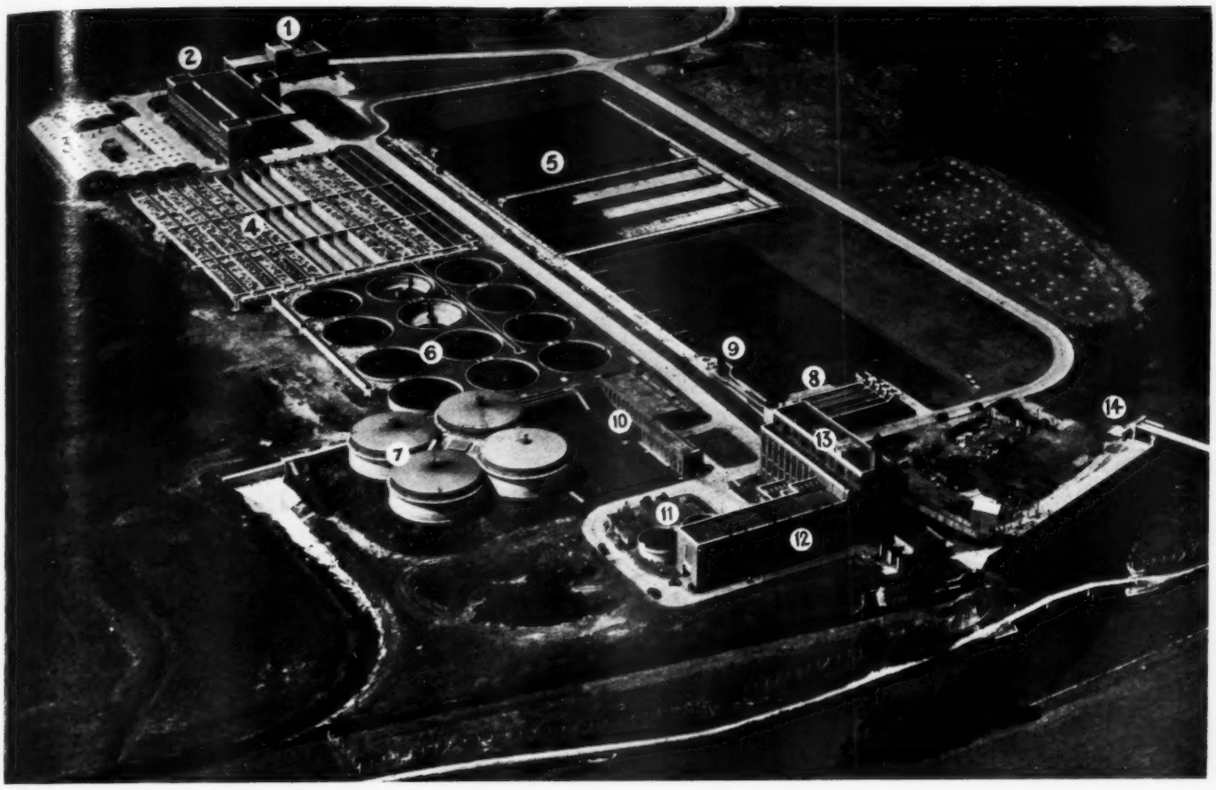
Growing tests were undertaken, using the normal long composting method employed with so-called synthetic composts. In this method the straw (wheat) is thoroughly soaked and the activator added at stacking. Turns by mechanical turner were made every six days and on the fourth turn gypsum was added and the compost put on to the growing shelves. The spawn used was of the grain variety, the casing was a peat/chalk mixture. The weights of mushrooms picked every day were carefully charted after grading. The weights taken were only of those that were actually marketed. After nine weeks' cropping the figures were: M.R.A. (blood), 2,424 lb. per sq. ft.; activated sludge (based on M.R.A.), 2,835 lb. per sq. ft. Although the

TABLE 3

Compost made from	Stable manure	Activated sludge
Top dressing	Dried blood	Activated sludge
Moisture, %	47.8	49.2
Solids, %	52.2	50.8
On a dry basis:		
Volatile matter (800° F.), %	24.2	26.5
Ash, %	75.08	73.5
Total nitrogen, %	1.01	0.98
Nitrate nitrogen, %	0.013	0.015
pH value (water extraction)	7.0	6.9

TABLE 4

	Blood	*Activated sludge*
Moisture, %	72.2	77.2
Total nitrogen (dry basis), %	2.49	2.72
Soluble nitrogen, %	0.44	0.67
Ammoniacal nitrogen, %	0.21	0.43
Albuminoid nitrogen, including urea, %	0.03	0.03
pH value	6.8	7.6



An aerial view of the Colne Valley Sewerage Board works at Rickmansworth, Hertfordshire, England. An idea of the scale can be gained from the fact that each aeration channel (4) is 100 yd. long

KEY:
(1) Administration building
(2) Electrical generating station
(3) Stores and maintenance workshops
(4) Aeration channels
(5) Sedimentation tanks
(6) Final settlement tanks
(7) Digestors
(8) Grit channels
(9) Disintegrators
(10) Pumping station
(11) Digested sludge washing tanks
(12) Filter house
(13) Furnaces and driers
(14) Intake pipes

earlier flushes were in favour of the blood activator, the later flushes were heavier in the case of the activated sludge and in the time of cropping there was actually one more flush.

Use by growers

Since then many tests have been completed, some as a complete synthetic and others as a boost to racing stable manure. These have confirmed the accuracy of the above detailed test and in the case of additions to stable manure have increased crops at a rate of 11–25%, improving quality at the same time. As a result of these tests and their own experiences, a large percentage of the growers of mushrooms and cucumbers in the British Isles have adopted the use of activated sludge in pure or modified form.

During composting it must be mentioned that the heat created is almost invariably increased and temperatures of 160–170° F. have been reached. It has enabled the composting time to be reduced. When used with cereal straws the breakdown of the straw has been good and the resulting compost normally of a good dark colour.

Its effect on grasses was tested by a well-known golf course management, who reported, ' It is interesting to note that on all the greens treated the grass has benefited and there is no sign of clover or yarrow having been encouraged '.

Production for sale

As a result of the early tests a pilot bagging plant was installed. Although the works are naturally producing activated and digested products 24 hours per day, seven days per week, the plant was only working a day shift and therefore producing only a few tons a day. Modifications have already had to be made to considerably increase the tonnage. However, at the moment only one type can be handled at a time, and this, of course, considerably reduces possible tonnage. Plans are now being made for further extension and by the time this article appears in print considerable progress should have been made in the construction of a plant purely for fertiliser purposes. The eventual production will be about 30,000 tons of activated and digested sludge a year.

As mentioned above, both these products were excellent fuel and, of course, when they are all sold for use as a fertiliser coal will have to be used in the drying process. Consequently the price at which it is sold will have to be in relation to the cost of coal as a fuel plus returns for the capital expenditure. Even so, the unit value of the fertiliser contents is much lower priced than that in dried blood, hoof and horn meal, meat tankages and other comparable products. Many manufacturers have taken advantage of this and are using both activated and digested sludges and mixtures of both as the basis of their organic compound manures.

Photo: Colne Valley Sewerage Board.

A NEW FERTILISING PROCESS FOR THE IMPROVEMENT OF UNPRODUCTIVE SOIL*

ANDRE BIRRE

In this article M. Birre discloses a new process that has been developed for the production of humus from urban wastes. The process has been watched closely by the Paris municipal authorities.

SOME of the world's most eminent scientists and statesmen have warned us that present-day prosperity is precarious because man is destroying the very soil under his feet.

Facts bear this out and are strongly indicative. Notwithstanding the enormous progress of civilisation, more than half the population of the world is underfed and over a quarter of the world's people actually suffer from famine. Whereas the population of the globe has increased from 400 millions in the middle of the 17th century to over 2,400 millions in the middle of the 20th century, man has destroyed nearly 1,000 million acres of fertile land which would be essential for the production of sufficient food to nourish adequately the populations at present underfed.

Civilised peoples have done their utmost to remedy this state of things by intensifying production, but unfortunately this process has brought in its wake, in place of famine, a whole series of illness known as ' Diseases of Civilisation ' (see de Castro, Juan, ' Geopolitique de la Faim ').

Circumstances have led me to make an intensive study of this question with various research committees during the past 20 years and I am prompted to analyse the situation before describing an efficient solution to the problem which has been discovered, thanks to the perseverance of a team of scientists and technicians. In due course the new discoveries will make it possible to stop the progressive impoverishment of land and to improve the present situation.

The Cause

By studying the natural processes of animal and vegetable life it is easy to understand that reduced fertility of the soil is in most cases due to the practices of man.

Natural state

In the virgin forest we can observe the natural state of things: trees rise to a great height, the undergrowth is thick and luxuriant and is populated by swarms of insects. Animals and birds are incredibly numerous and a soft spongy layer of dead leaves and droppings from the plants and animals covers the soil, continually enriching it. Most important of all, perhaps, the topsoil is formed of a thick layer of dark-coloured humus which is populated by rodents, insects and worms, who move it, aerate it and break it up.

A microscopic examination of a particle of this humus shows in turn the presence of countless numbers of micro-organisms whose development and activity seem almost incredible. Thousands of millions of active organisms are at work to return to the soil the leaves and other waste matter which cover it. Some attack minerals, integrating them with the organic substances; some collect trace elements from the atmosphere; others form the connecting link between the organic and mineral substances and the roots of plants.

During the course of millenniums forests grew over layers of stone and other minerals, thanks to the action of micro-organisms which created the necessary humus. The life force originating from the humus after reaching the highest points of the plants is from there inevitably returned to the soil, and because of this cycle virgin forest can produce in a year a greater quantity of organic products than the most progressive agriculture; in it the growth of textile fibres is 20 times more abundant than in a cultivated cotton field of equal area.

The vast expanse of prairie in America had the same luxuriant aspect before its discovery by man, thanks to a similar cycle, whereby most of its production returned to the soil, thus reconstituting the natural layer of humus. Over 100 million bison and other animals lived on these prairies, but the organic products consumed by these animals for their nourishment were largely returned in the form of excreta to the soil from which they had been obtained.

Action of man

The arrival of man changed all this. His first preoccupation was that of harnessing the beneficial effects of the natural layers of humus for the development of agriculture. As a result many troubles began to develop one after the other. The indiscriminate destruction of forests and ploughing up of the prairies exposed the soil to the elements. Inevitably erosion commenced and in a few years the natural layers of humus in the topsoil, created by nature during the course of millenniums, were destroyed.

Because of this action, during the last century and a half over 1,000 million acres of fertile land have been greatly impoverished. Over a longer period, and by different but nevertheless destructive measures, once-fertile lands in North Africa and the Middle East have been turned into deserts.

In the distant era when man lived from the results of the chase nature adequately supplied his wants; the progress of civilisation altered this, and man attempted more and more to impose his will upon nature itself.

When natural resources were exhausted he moved elsewhere. The evolution from nomadic tribes to settled communities brought new problems, but in its wake came the discovery that the use of animal fertiliser and the careful rotation of crops could compensate nature for what man took away. Animals were kept for the value of the manure they could produce as well as for their other advantages, and thanks to this it became possible for stabilised communities to develop. Thus began Western civilisa-

* Translated and condensed by John A. Walters.

tion, which maintained its principles of land husbandry throughout the ages until the discovery of new lands across the ocean brought a period of regression. In fact, the original settlers did not need to return humus to the new rich land to obtain good crops.

The industrial revolution and consequent concentration of the population in towns accelerated the progressive impoverishment of the soil. Organic produce obtained from the land in ever-increasing quantities was transported to the towns in the form of food, textile fibres and wood, but the unused remnants of these products and other forms of waste were no longer returned to the soil. In fact, owing to the ever-increasing volume of refuse which was a source of infection and a breeding ground for vermin, it became necessary to destroy this by incineration.

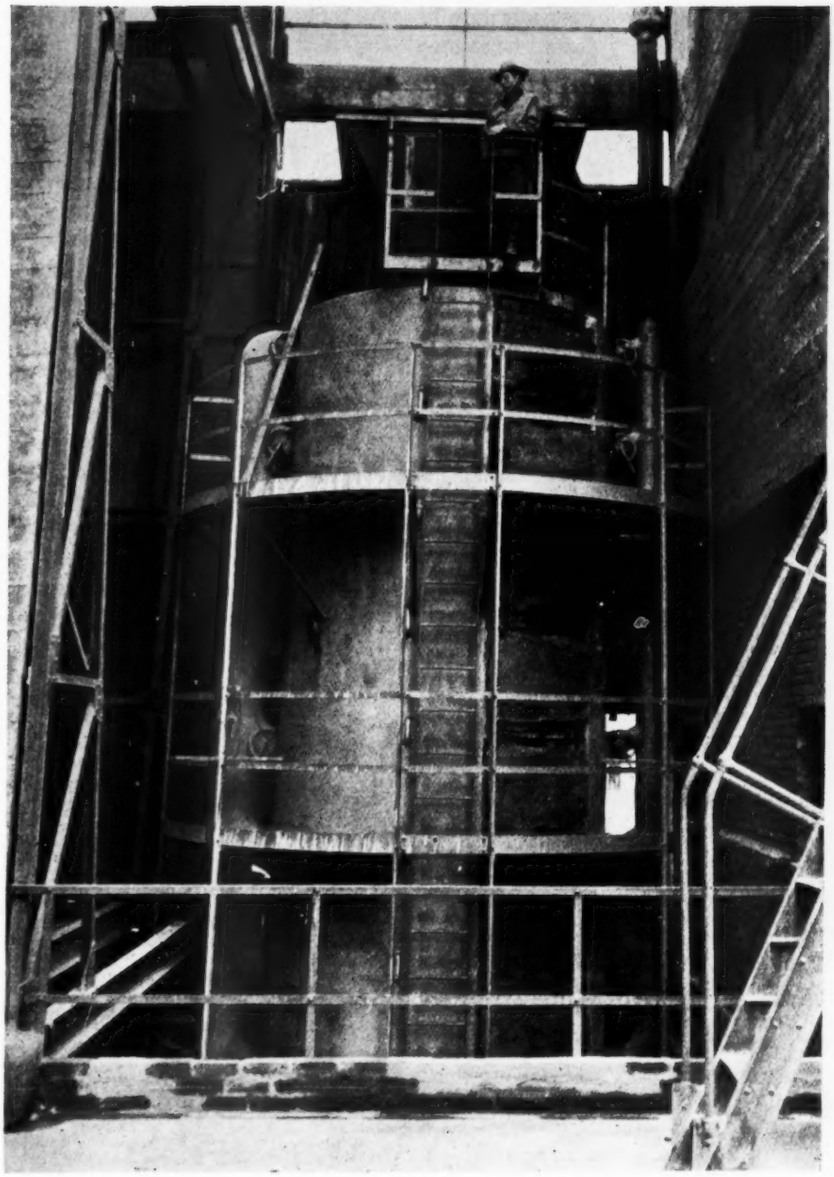
Mineral fertilisers

The introduction of mineral fertilisers greatly improved the productivity of agricultural land, but no one realised that this improvement was only achieved because the mineral fertilisers succeeded in mobilising the remaining reserves of energy in the soil, and that consequently the results achieved could only be temporary. Unfortunately, however, owing to the temporary effectiveness of the mineral fertilisers, a tendency developed amongst farmers, as it had done in the past amongst the settlers in America, to ignore the value of manure and to reduce their livestock, since tractors could do the haulage jobs more cheaply and effectively than animals. Under pressure of competition from overseas European farmers have increased their productivity to the limit and have adopted the use of mineral fertilisers almost to the exclusion of manure, thus accelerating beyond measure the wastage of natural fertility in the soil.

The natural consequence could not be avoided and the reduced fertility allowed free scope for the development of parasitic insects and diseases of plants and animals; amongst humans the resistance to illness was lowered and the so-called diseases of civilisation were recognised.

The discovery of poisons to deal with insect pests, vaccination for animals and humans, antibiotics and vitamins successfully dominated these troubles, but have not eliminated their cause.

Fortunately, men with foresight realised the situation and began to study the possibilities of a remedy.



Top three sections of digestor installed at Romainville, lagged to conserve heat generated by bacterial action

The Remedy

The primary requirement was the return to the soil of the equivalent of at least part of the vast quantities of organic produce obtained from it each year. In the present-day world the only available waste organic matter is to be found in the garbage dumps and sewage farms where the waste of cities and industries is collected.

A study of the natural processes of fermentation and of the enormous power of micro-organisms convinced scientists that it was possible to transform these materials into humus, thus making their return to the soil feasible and economical. Needless to say, the realisation of this possibility and its practical application were difficult to reconcile.

Bacterial method

Early in the 20th century an eminent American scientist, Dr. Earp-Thomas,

began his researches in connection with the problem. Many years of patient effort were crowned with success when he succeeded in isolating colonies of bacteria and blending them so that they will transform waste organic matter into humus. Further research enabled him to discover a method of achieving the transformation rapidly and he patented an apparatus called ' continuous-flow digestor '. This consists of a vertical cylinder divided into eight sections or floors and fitted internally with rotating booms. The organic waste, after having been ground to a pulp-like consistency, is introduced to the top section of the digestor and is there inoculated with a charge of active bacteria. The rotating booms stir it continually and convey it slowly towards an aperture that allows the material to fall on to the floor below; here more rotating booms continue to stir it and convey it to another aperture, through which it again falls into a lower section.

The same process is repeated eight times before the material leaves the digestor. The temperature of the material rises sharply owing to the action of the bacteria, and by the time it reaches the fifth section is more than 180°F. in temperature, so that complete pasteurisation is obtained and all harmful germs and parasites are destroyed. The material takes 24 hours to reach the opening through which it leaves the digestor, and in this period is completely transformed into fine granular humus. It has the appearance and smell of mould and is ready for spreading on the soil.

Results

Experiments have shown that humus thus obtained will, in three years, regenerate soil that has been completely exhausted, and in all cases where it has been used a very definite improvement has been achieved, not only in the quantity, but particularly in the quality of the products obtained. In particular it has been found that crops grown on land treated with humus produced by the Earp-Thomas process have a much greater resistance against frost, insects and disease.

Advantages

This discovery makes it possible to achieve the following results:

1. Putrescible organic waste and sewage can be treated rapidly and efficiently in urban dumps.
2. After treatment the resulting humus is neither malodorous nor insanitary and can therefore be stored and transported with ease.
3. Organic waste can be returned to the soil where it is required and not destroyed by incineration.
4. The quality of agricultural products can be greatly improved.
5. Large areas of impoverished land which are no longer economical to farm can be reclaimed and brought back into full production.

Paris experiment

The first practical installation for the Earp-Thomas process in Europe was constructed in France, thanks to the tireless efforts of Monsieur Armand Daudier, who installed a digestor in Paris and after a period of experimental operation has now commenced production on a commercial scale. Needless to say, the process has created enormous interest in France, particularly after the installation of M. Daudier's pilot plant, and the Paris Council are interested in installing similar plants in all their refuse dumps.

Before the full benefits of this discovery are felt by humanity, however, it will be necessary to convince farmers that it is a dangerous policy to rely exclusively on mineral fertilisers, and it is hoped this article may help to bring to the notice of the farming communities the dangers towards which we are heading, and assist them in evaluating the advantages of this new process.

Rockefeller Grant for South Pacific Commission

The rhinoceros beetle, dreaded scourge of South Pacific coconut plantations, quailed when news of a Rockefeller grant of 45,000 dollars to fight the pest was announced by Dr. Ralph Clairon Bedell, Secretary-General of the South Pacific Commission.

Multiplying loathsomely in the hollows of rotted logs and other unsavoury breeding places, the rhinoceros beetle eats its way into coconut palms and lays waste whole plantations on which many islanders depend for livelihood. Near-panic occurred in the South Pacific when news came in 1953 that it had spread to Fiji.

The rhino is already being stalked by two entomologists of the South Pacific Commission—Dr. R. A. Cumber, working in Western Samoa, and Mr. T. V. Venkatraman, in East Africa and South-East Asia.

The Rockefeller grant will substantially accelerate the S.P.C. research programme, aimed at helping governments combat the ravages of the huge rhino-like insect.

Research will concentrate on possibilities of control through introduction to the islands of parasites, predators and pathogenic micro-organisms.

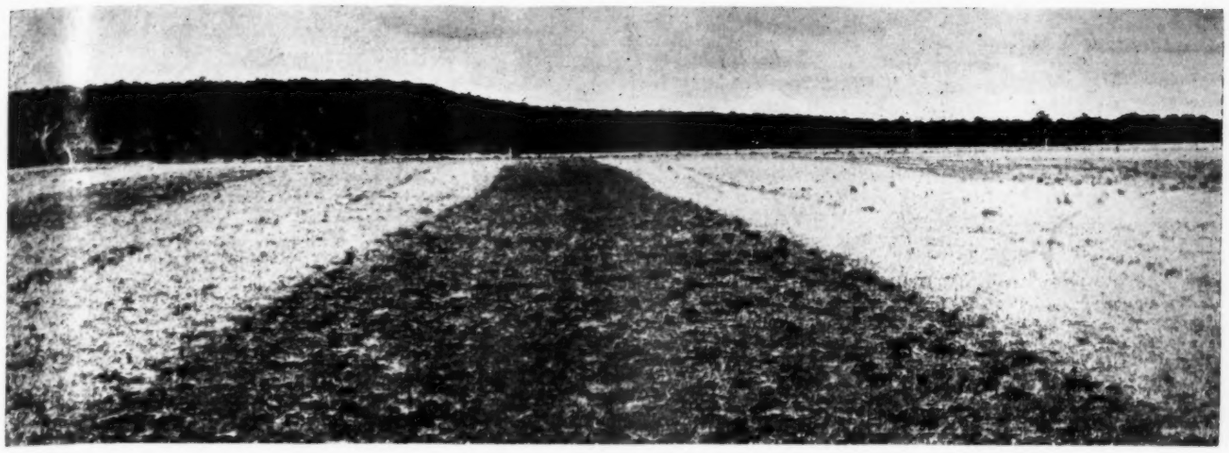
Spanish-Egyptian Rice Negotiations

It has been reported from Valencia that Spanish rice interests are to hold talks with Egyptian authorities to discuss ways of avoiding competition in rice exports. This follows a recent agreement between Spanish and Italian rice interests and is aimed at improving the price of rice exported by the three countries, particularly to Japan.

Talks between Spanish exporters and Japan for the sale of a substantial quantity of Spanish rice from the 1954 crop have been suspended pending an agreement between Spain, Italy and Egypt.

Borneo Rubber Cultivation

Rubber trees are being replanted in the North Hulu Sungai regency of South Kalimantan (Borneo) over a total area of 300 hectares (approx. 740 acres) by a new method whereby a smaller number of trees are planted per hectare (300 as against 600-800 previously), but a higher yield is obtained. The resultant space between the trees can be used for other crops which provide the rubber-growing smallholder with an additional source of income to offset any fluctuations in the price of rubber. The total area under rubber cultivation in Kalimantan is 315,000 hectares, with approximately 74,000 trees. 550 hectares have previously been replanted by this method, which, in the next five years, will be extended to 30% of the total rubber-growing area.



Loss of colour is a symptom of sulphur deficiency. The centre strip is normal

SULPHUR RESPONSES IN AUSTRALASIA

T. W. WALKER, A.R.C.S., B.SC., D.I.C., PH.D.

(*Professor of Soil Science, Canterbury Agricultural College, New Zealand*)

Sulphur is a vital plant nutrient, particularly for the growth of legumes. In this articte Prof. Walker has outlined some af the recent work dealing with the effect of this element on pastures and in his conclusion states 'It is highly likely that there are many areas in the world (one thinks of tropical legumes) where sulphur deficiency may be of considerable importance . . . it is worth examining the question of sulphur responses.'

ONE of the benefits arising from the temporary shortage of sulphur, with its consequent effect on the manufacture of sulphuric acid and superphosphate in 1951–52, was the attention it directed to alternative forms of phosphate fertilisers and intensification of research into the significance of the sulphur contained in superphosphate as sulphate of lime.

In the 18th and early 19th centuries gypsum (sulphate of lime) was widely used as a fertiliser in the United Kingdom and the U.S.A., sometimes with remarkable results. After Lawe's development of the manufacture of superphosphate in the 1850s very little attention was paid to the significance of sulphur as a plant nutrient, and almost the only reference in recent standard textbooks to the occurrence of sulphur deficiency was the effect of sulphur in curing tea yellows in Nyasaland. Elementary sulphur and sulphates of iron and aluminium have been widely used to correct excessive alkalinity, and gypsum has been applied in attempts to improve saline soils. Only in the last five years has it been realised that sulphur deficiency may be quite widespread in some countries, and increasing attention is being paid to this element, which is important in plants and animals for the synthesis of some amino-acids and proteins.

Recent research

Recent work in Australia[1, 2] has shown quite clearly that sulphur is a vital plant nutrient, particularly for the growth of legumes and, therefore, pastures. In New Zealand, Doak[3] had shown in 1929 that lucerne responded to applications of sulphur or sulphates, but nothing was done about it because it was assumed that wherever superphosphate was applied (and little else except lime is applied in New Zealand) any need for sulphur would be met automatically. More recently a trial at Palmerston North conducted by Sears[4] indicated a marked benefit in clover growth from applications of superphosphate in spite of a high soil-phosphate level, and it was shown that the response was due to the gypsum in the superphosphate. Trials by Lobb[5, 6] have shown marked responses by legumes and brassicas to sulphur or its compounds. In Canterbury we have had outstanding responses to calcium sulphate on the establishment and growth of oversown clovers in the tussock grasslands on the foothills of the Southern Alps.[7]

Plant nutrition

These observations in Australasia have forced us to reconsider the whole question of the importance of sulphur in plant nutrition with particular emphasis on pastures. It is a common experience that the first effects of rectifying sulphur deficiency are seen in improved growth of legumes, and as little or no nitrogen fertilisers are used on pastures high production can only be obtained by stimulating legumes to fix more nitrogen, which, on excretion by the grazing animal, stimulates grass growth. It is worth looking briefly at the sulphur cycle, which bears a striking resemblance to the well-known nitrogen cycle.

Sulphur occurs in some primary rocks as sulphides, but except in poorly drained soils sulphides are readily oxidised to sulphates and, if not absorbed by plants, may be leached from the soil where rainfall exceeds transpiration and evaporation. In the majority of soils most of the sulphur is in the organic form and there appears to be a fairly constant N : S ratio of about 8–12 : 1. During the decomposition of soil organic matter by micro-organisms some of this organic sulphur is converted to sulphate at the same time as the nitrogen is mineralised to ammonia or nitrate. On poorly aerated soils some of this sulphate may be reduced to hydrogen sulphide and lost to the air and nitrate nitrogen may also be lost by denitrification.

Sulphur may be added to the soil in rain-water as sulphates or sulphites, the amounts varying enormously in different regions. In rural parts of America and at Canterbury Agricultural College only some 6–10 lb. of sulphur per acre may come down in the rain, whereas 200 lb. or more may be precipitated in the neighbourhood of industrial areas. Coastal regions may get a bigger return than inland areas, as some sulphate will be included along with the common salt in the coastal spray, which is carried some miles inland. Plants may also absorb sulphur dioxide from the air in exactly the same way as they absorb carbon dioxide in the photosynthetic processes. Plants appear to need sulphur and nitrogen in a fairly definite ratio, so that if absorbing excess of nitrate in relation to sulphate, nitrate tends to accumulate in the plant;[1] similarly, if plants absorb relatively more sulphate than nitrogen, inorganic sulphate accumulates in the plant. Both these factors may influence animal health.

Nitrogen fixation

One major difference between nitrogen and sulphur is that legumes, given an adequate supply of other nutrients, can fix large amounts of nitrogen from the air. Under the best climatic conditions in New Zealand, for instance, improved strains of white clover may fix 600 lb. of nitrogen per acre. If we assume that plants normally contain about 10 times more N than S, then some 60 lb. of S are also needed if this amount of N is to be fixed. A small amount of this S may come from the mineralisation of soil organic matter, but in rural areas remote from the sea it is doubtful if these sulphur needs can be met without addition in the form of fertilisers.

It is interesting to see what probably happens to this nitrogen and sulphur. When land is set down to pasture, organic matter tends to accumulate; the rate of accumulation of this organic matter is governed by many factors, not the least important of which is the rate of accumulation of N. Eventually after many years a state of equilibrium may be reached at which point losses of organic matter equal gains. Some of the nitrogen fixed by clovers in a pasture will be lost, but these losses are least in a grazed pasture and there is evidence that not more than 30–40% will be lost at the most. The eventual equilibrium level of soil nitrogen has been shown to be very high under the best New Zealand conditions,[8] and so 400 lb. of N per acre and associated carbon and sulphur (say, 4,000 lb. and 40 lb. respectively) may accumulate in soil organic matter yearly over a long period of time. In other words, during the phase of organic matter accumulation under pasture there is a continual need for sulphur, the amount being governed by the rate of N fixation by the leguminous constituents of the sward. The same reasoning probably applies to phosphorus, too, because normal soil organic matter appears to contain C, N, S and P in fairly constant proportions of, say, 100 : 10 : 1 : 1. It is thus easy to see why a fertiliser such as superphosphate (which supplies both S and P) may be supremely important on permanent pastures or long leys where clovers are being relied upon as the source of nitrogen, and a shortage of either phosphorus or sulphur may be expected to show up in reduced growth of legumes and a widening ratio in the soil organic matter of C to N, S and P.

Aerial application

Some of these ideas and their implications can be best appreciated by reference to results that have been published elsewhere.[7] In the South Island of New Zealand there are some 12 million acres of mostly unploughable tussock country. These are natural grasslands or have been converted to grassland after the burning of the original forest or scrub cover. Their production is low and in some areas, partly because of over-grazing, erosion is severe. Until the advent of aerial application of fertilisers little could be done to improve such country, but with the tremendous strides now made in aerial fertilising it has become possible, dependent on costs and returns, to consider the application of fertilisers, lime and the over-sowing of improved strains of clovers. It is costly to apply large quantities of lime from the air, but the possibility of using a few ounces of sodium molybdate instead has been discussed previously.[9]

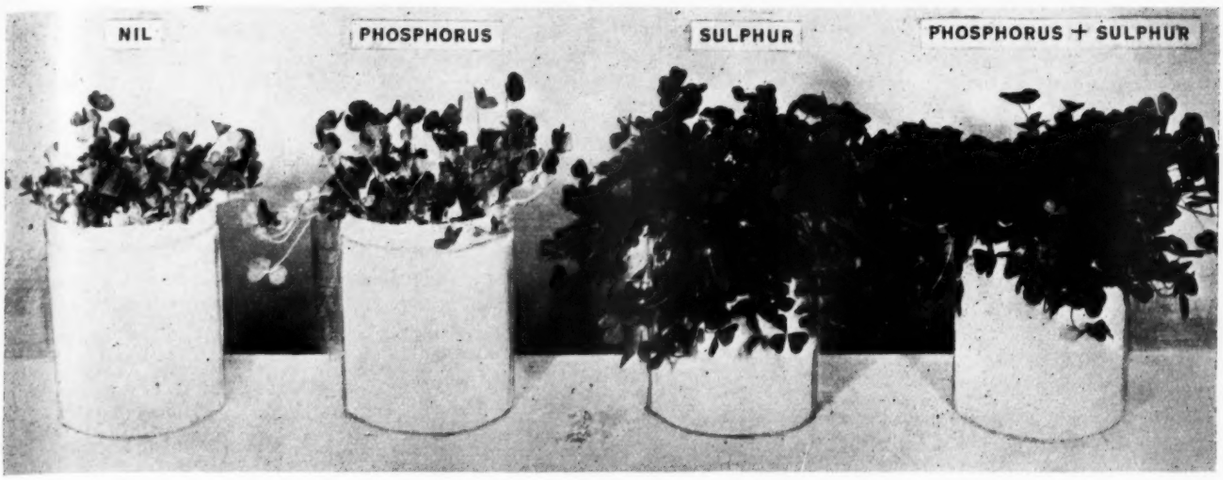
Trials with all combinations of gypsum, triple superphosphate and molybdenum were put down in typical Canterbury tussock country in the spring and the trial areas fenced off after over-sowing with a mixture of red, white, alsike and subterranean clovers. After five months the plots were cut and clovers separated for weighing and analysis. Some of the results from only four of the trials are shown in Table 1 to illustrate the effects.

For Centre 1 it is clear that gypsum has had the most outstanding effect on clover growth, with only slight responses to phosphate and molybdenum. This soil, on analysis, was rich in ' available phosphorus ' and the very slight response to triple superphosphate might have been expected. If, however, superphosphate (equivalent to triple super + gypsum) only had been used in this trial there would

TABLE 1

YIELDS OF CLOVER, LB. OF DRY MATTER PER ACRE

Treatment	*Centre* 1	2	3	4
Control	67	9	0	41
Triple super, 100 lb./acre	103	86	22	290
Gypsum, 100 lb./acre	866	64	175	19
Triple super + gypsum	986	406	465	70
Triple super + gypsum + sodium molybdate, 4 oz./acre	1,088	531	497	268



The response to sulphur in pot cultures. Left to right: *control, phosphorus, sulphur, phosphorus + sulphur*

have been an outstanding response, due almost entirely to the gypsum in it, and phosphate may have been given all the credit for the response. This big response to superphosphate in view of the satisfactory phosphate status of the soil would have been puzzling and may have led to a condemnation of the particular method of soil analysis used.

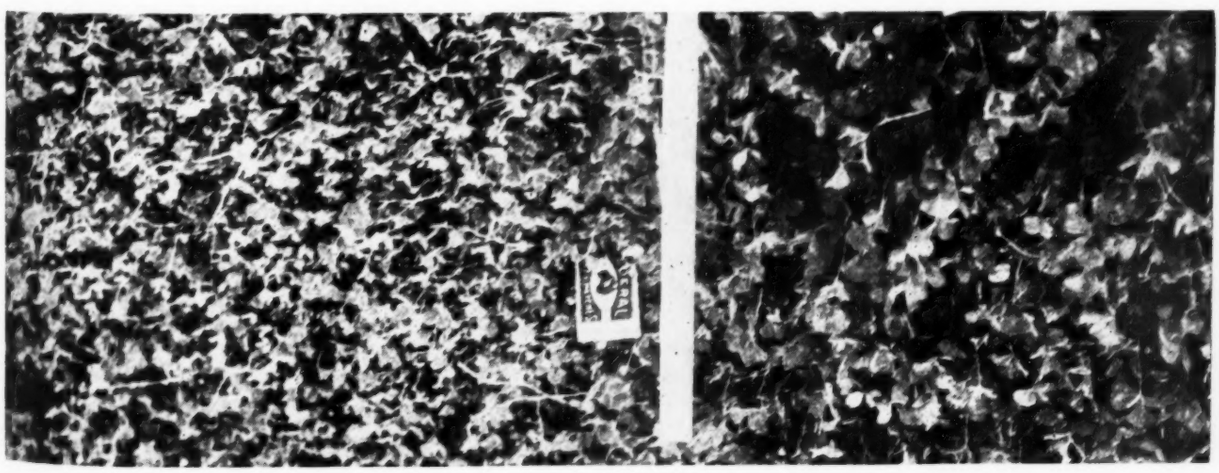
Centres 2 and 3 are similar in that there were slight responses to gypsum and phosphate separately, but a very pronounced positive interaction; in other words, both nutrients were deficient, and both were needed to get good responses. These two soils, on analysis, were moderately deficient in 'available' phosphate.

The results at Centre 4 are particularly interesting and can be used to illustrate the complexity of the whole situation. It can be seen that triple super gave a marked response (the soil was very deficient in 'available' phosphate on analysis), gypsum gave a depression, superphosphate (triple super + gypsum) had little effect, whereas molybdenised superphosphate (triple super + gypsum + sodium molybdate) yielded about the same as triple super. If superphosphate only had been used on this soil it may have been concluded that the soil had a high capacity for fixing phosphate, whereas phosphate alone gave a big response. If molybdenised super had been compared with straight super, molybdenum deficiency may have been inferred, and this is only partially correct. Soil and plant analyses and other experimental evidence[10] offer the following explanation: The soil is only moderately acid (pH 5.7), but contains a high level of exchangeable manganese, and clovers contained toxic quantities of manganese. Application of gypsum (as would almost any salt) increased manganese uptake and depressed clover yields. It has been shown elsewhere[10] that there is a marked manganese–molybdenum antagonism, high levels of manganese immobilising molybdenum within the clover or perhaps even reducing molybdenum uptake. Hence the application of molybdenised super reduced the effects of manganese toxicity enhanced by the gypsum.

Some interesting conclusions can be drawn from these observations and generally accepted views on the subject of phosphate fixation can be questioned.

Need for sulphur

In the first place these results add further to the increasing evidence of the need for sulphur in Australasia. For the improvement of the high



Showing the effect of sulphur applied without phosphorus. (Left) *sulphur;* (right) *untreated*

country in New Zealand, aerial application of fertilisers is the only means of tackling the problem. Because of the widespread belief that only the phosphate in superphosphate is of any value, it has been assumed that triple super, because of its high phosphate content and granular nature, would be ideal for aerial sowing. Our results indicate that it would normally be much inferior to superphosphate. Wherever superphosphate is being compared with other forms of phosphate (*e.g.* slag or rock phosphates) it would be wise to include gypsum with these other phosphates or bring triple super into the comparison. On some soils the superiority of super over rock phosphate may be due to sulphur responses, and in some acid soils the superiority of slag over super may be due to the effect of the gypsum in the super, inducing manganese–molybdenum antagonism. Poor responses to phosphate on deficient soils have often been loosely attributed to P fixation when other nutrients may have been deficient (*e.g.* molybdenum, zinc, copper or sulphur) or present in toxic quantities (*e.g.* manganese). In the latter case, as liming reduces manganese availability and uptake, it has been too readily assumed that phosphate is fixed more readily on acid soils than on limed soils.

We have reported on an experiment[10] where lime or molybdenum increased clover growth on an acid soil sevenfold. The phosphate content of the untreated clovers was, however, seven times greater than in the treated clovers, and the uptake of phosphate was similar under acid or limed conditions; in other words, phosphate was just as available to the plant under all conditions. Many of the laboratory experiments on phosphate fixation have been mere exercises in complicated inorganic chemistry and the whole question of so-called phosphate fixation needs urgent re-examination.

'Complete' fertilisers

There would appear to be two major conditions under which a marked need for sulphur may arise. Much must depend, of course, on the amount of sulphur returned in rainfall or absorbed by plants from the air and the need for sulphur will vary widely with the location. On the one hand sulphur is important during the phase of organic matter accumulation either with grass–legume associations or with straight legumes, because sulphur appears to accumulate along with carbon, nitrogen and phosphorus in the organic matter, and a shortage of sulphur will lead to lower nitrogen fixation and poorer growth of legumes. It is impossible for legumes to grow and increase the carbon and nitrogen contents of the soil without corresponding amounts of sulphur.

Secondly, under a system of arable cropping, normal organic matter will be slowly decomposed, liberating inorganic sulphur, nitrogen and phosphate. If fertilisers are used to increase production, sulphur must necessarily be included in the mixture unless the rate of breakdown of sulphur in organic matter, together with atmospheric supplies, are sufficiently high to meet the needs of the crop. So-called 'complete' fertilisers of the concentrated type containing little or no sulphur might be expected to lead quickly to conditions of sulphur deficiency.

In New Zealand, where superphosphate and lime have been the means of transforming large areas into high-producing pastures, farmers have unwittingly supplied two of the main nutrients (sulphur and phosphorus) that are essential to maintain high production and also allow for the accumulation of large amounts of soil organic matter. It is highly likely that there are many areas in the world (one thinks of tropical legumes) where sulphur deficiency may be of considerable importance. Even in England, where in many areas the return of sulphur from the atmosphere is high, the writer can think of two rural areas in the West Midlands—on the Welsh borders and on some of the soils of the Lias clay in South Warwickshire—where, on soils high in 'available' phosphate, pastures still responded well to superphosphate. Wherever legumes, grass–legume associations and crops such as the brassicae and onions with high sulphur requirements are grown it is worth examining the question of sulphur responses.

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Photos: C.S.I.R.O., Australia.

Coffee and Cocoa in New Guinea

Coffee and cocoa growing are receiving increasing attention in the agricultural development of Australia's territory of New Guinea, according to Queensland's Under - Secretary for Agriculture, Mr. A. F. Bell, who toured Papua and New Guinea with the Australian Standing Committee on Agriculture, of which he is chairman.

The productive capacity of the soils was high and the programme of development was encouraging coffee and cocoa particularly and the raising of fibres. This was valuable, as the products would not be competitive with Australian crops.

Australia produced practically no cocoa and in 1951–52 imported more than £A4,500,000 worth. It also grew very little coffee, and in the same year imported £A1,250,000 worth. Prices being received for the New Guinea crops were favourable and the Administration believed the outlook to be good.

However, development was more expensive. A European coffee or cocoa grower required at least £A15,000 capital for these industries, and as the natives became more interested in agriculture the grower would be faced with mounting competition for available labour. The natives were showing increasing interest, particularly in co-operative effort in the processing of coffee and cocoa and, in some instances, in the co-operative owning of agricultural machinery.

The Swedish Friesian breed is most common in the south

Sweden—A Dairying Country

RICHARD HÅKANSSON

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Swedish farming today is characterised by high production and advanced rationalisation and, during the post-war years, by very extensive mechanisation. Alongside England, Sweden is perhaps the most highly mechanised farming country in Europe. The number of tractors in agricultural use has increased five times between 1938 *and* 1953, *when it amounted to about* 110,000, *and the number of horses decreased by about* 250,000. *The production in agriculture per man-hour has risen by about* 60% *since pre-war days. Mr. Håkansson, who has agreed to become a regular correspondent, enlarges on some of the views given in the article by Mr. Gordon, which was published in* WORLD CROPS, **7**, 410, 1955.

ONE interesting fact in Swedish agriculture is the decrease of the rural population. As far back as the latter part of the 19th century the agricultural population was comprised of more than 3 million people, or nearly 70% of the inhabitants. Today it is something like 1.5 millions, or about 20% of the total number of inhabitants. At the same time, production has been growing steadily, so that, whereas we formerly had to import considerable quantities of food and feeding-stuffs, we are today more than self-supporting—the total population of Sweden is 7.3 million people. The situation, then, is that the production in an average year is about 10% higher than the consumption, which, of course, gives us a surplus for export.

Together this increase in the production and decrease in the use of manpower have caused something that might be called an agrarian economic revolution. During the last 15 years the volume of manpower used in agriculture has decreased by 30% and during the same time the production per man and hour has gone up by 60%. Thanks to this development, it has been possible to keep the prices of agricultural products relatively low.

It is a fact that, except in Denmark and the Netherlands, food prices in Sweden (both the prices that the farmers get and the prices that the consumers pay) are lower than in other European country. This is the more remarkable when it is remembered that the natural conditions in many parts of Sweden are unfavourable and that, at the same time, wages are among the highest in Europe. Farm workers, for instance, earn an average of three Swedish kronor (1s. equals 0.72 kronor) per hour.

Woodland predominates

Although Sweden is situated on the same latitude as Alaska, Southern Greenland and Siberia, farming conditions are fairly good. The warm waters of the Gulf Stream give a mild climate, considering the northerly position of the country. Owing to the length of the country (about 1,000 miles), however, the climate varies a good deal; and with an average temperature of more than 10° C. the length of summer varies from 4.5 months in the south to two months in the north (Lapland). The short summer is, of course, a serious drawback, but it is to

some extent compensated by the long days in the northernmost parts of Sweden—the Land of the Midnight Sun—where rye and barley ripen in the prolonged sunshine. Potatoes and vegetables grown in the north are of very high quality. Plant improvement has served to develop exceptionally hardy varieties of grain for northern cultivation.

The number of months with a mean temperature below freezing point is two or three in southern Sweden, four in Stockholm and no less than seven in the north. The number of days when the ground is covered by snow varies from 30 to 40 in the south to 240 in north-western Lapland. The average rainfall is about 20 in. per year. This is roughly what is needed for the crops, except in the dry eastern coast districts, but farmers always complain that they never get it when they want it, a complaint that is often justified during the harvest time.

Woodland predominates, and only a small part of the country, one-tenth, is suitable for farming. In some of these districts the climate is so hard that yields must necessarily be rather low. The arable land amounts to approximately 3.7 million ha. and permanent pasture to about one million ha.

The percentage of arable land varies in different districts. In the southern third of Sweden the arable land amounts to about 22%; on the plain of Skåne it rises to 84%. In upper Norrland, on the other hand, it is less than 1%.

The traveller reaching Sweden from the south first becomes acquainted with farming in Skåne, where the type of crop differs greatly from that of the rest of the country. Large quantities of wheat, sugar-beet, barley and oilseed are grown there. Farming in the southern provinces may very well be said to be equal to that in the most progressive agricultural districts of Europe. Crop production is usually organised in a typical crop rotation, such as the Norfolk rotation, well known in England. Crop rotation in central Sweden is primarily characterised by two- or three-year leys with clover and grass and by very extensive cultivation of oats. These two crops occupy more than half of the total acreage. Typical rotations in this region are black fallow, winter grain, three years of clover and grass ley and two years of spring grain, which have in recent years been replaced to a large extent by oil crops. The further north we go the larger is the hay-crop (ley grassland) acreage. In the north it covers 80% of the cultivated land.

Sweden—a dairy country

Sweden is a dairy country and the largest part of the farmer's income arises from animal husbandry. From the total farm income about three-quarters come from animal products and only one-quarter from vegetable products. Milk is the most important single product, representing about 40% of the total farm income.

The number of cattle is at the present moment about 2.5 millions, almost all of them dairy cattle. There are three types; Swedish Red and White cattle (S.R.B.), a cross between Ayrshire and Dairy Shorthorn, are the predominant breed. In the south of Sweden Swedish Friesian cattle (S.L.B.) is the most common breed and in the north Swedish White Polled cattle (S.K.B.). The highest yield of milk comes from the Friesians, whereas the White Polled show the best fat content, ranging up to 5%. (The Polled cattle have two colour types, one entirely red, the other white with black spots.)

These three Swedish breeds are all dairy cattle. In addition, some herds of Jersey cattle are found in southern Sweden. No special beef cattle had been bred until a few years ago, when mainly Aberdeen Angus cattle were imported from Scotland. Since then there has been an increasing interest in beef cattle and a few other types, *e.g.* Shorthorn and Hereford, have been imported from the United Kingdom and are now being tried in Sweden.

Measures against bovine tuberculosis and contagious abortion have been subsidised jointly by the Government and the farmers' co-operative organisations. As a result of this campaign both these serious diseases have been rooted out.

Collecting, processing and selling of milk and dairy products are managed by the co-operative dairy organisations, to which 263,000 of Sweden's 400,000 farmers belong. Of all milk sold to dairies, about 98% is handled by these

Preparing the sowing bed—typical view from Central Sweden

co-operative dairies, which are affiliated to large regional unions. The Swedish Dairies Association (S.M.R.) is the central organisation.

The bulk of the milk comes from small herds, the average daily delivery per supplier being only 39 kg. The transport, which is now run by the dairy undertakings themselves, has been rationalised and it enables the dairies to maintain transport costs at a reasonable level. It has been possible to build up large modern dairy plants. As a result of the centralisation in the last 20 years the number of dairies has dropped from about 1,600 to about 600. Of the total milk intake, more than half is used for butter manufacture and a third for liquid milk and cream, the remainder being used for the production of cheese, dried milk, casein etc.

Milk and dairy products have long been the principal foods in Sweden. Due to their relatively low prices in comparison with their nutritional value, the consumption of them has for a long time been on a very high level. Not until recent years has margarine begun seriously to threaten butter as the edible fat with the biggest sale. The present annual consumption of milk and dairy products *per caput* is as follows:

Liquid milk ..	214 kg.
Cream	6 kg.
Butter	12 kg.
Cheese	7 kg.

These figures place Sweden in the foreground of *per caput* consumption of dairy products.

The export of all dairy produce, with the exception of dried milk and condensed milk, is in the hands of S.M.R., which, for that purpose, maintains relations with the principal importing countries. The average price to producers for milk containing 3.5% of fat, free dairy, is at the moment 36 öre (about 6d.) per kg. and the average price to consumers about 45 öre (8d.) per litre.

Hogs, sheep and poultry

Sweden has only two breeds of hogs: the English Large White and an improved native breed, Landrace. The difference between them is nowadays insignificant, for the breeding of both has been directed towards the same goal, a fast-growing, good bacon type. In recent years the domestic breed has increased at the expense of the English. As in other countries, the number of hogs in Sweden fluctuates more than that of other animals according to the trade cycle. At present the stock is about 1.5 millions.

Mechanisation of hay-making is still in the first stage in Swedish farming

There are four sheep breeds in Sweden: the native breed, Swedish Landrace, which is the most common, and the three English breeds, the Cheviot, the Shropshire and the Oxford Down. The native breed consists of two types: the Gotland 'outdoor' and the mainland sheep. These are smaller than the English breeds, but hardier. Only during the past 25 years has the sheep been subjected to systematic breeding, an activity which is supported by the State through yield tests and through subsidies to the stud ram associations. However, sheep breeding has never been very extensive in Sweden and today the number of sheep amounts to about half a million.

In the pre-war years poultry breeding developed rapidly both in quantity and quality, so that Sweden was able to export eggs to a considerable extent. The most important breed is the White Leghorn. Next in importance comes the Rhode Island Red. In addition to chickens, there are some ducks, geese and turkeys, particularly in the south of Sweden.

Swedish animal husbandry has made much progress in the past few decades. This is due to systematic breeding and registration, Government subsidies to stud associations of horse, cattle, hog and sheep breeders, award of prizes, and yield controls of various kinds, etc. However, there is still much to be gained, as, for instance, by breeding along scientific lines, by improved feeding, and by expanded yield recording. Both scientific research and practical experience have shown that great possibilities exist for increasing very substantially the productivity of Sweden's livestock.

Land ownership

Sweden is a country of smallholdings, owned by the farmer and operated by himself and his family. Of the farms having more than 5 acres of arable land, about 80% are operated by the owners and only about 20% are tenanted. However, the tenant farms are slightly larger than the rest, so that their acreage amounts to 26.5%.

There are about 300,000 farms of over 2 ha. of arable land. A little less than 200,000 of these are between 2 and 10 ha., and most of the rest between 10 and 30 ha. The number of big farms is low—only 2,000 farms of over 100 ha. Many big estates are found in southern and central Sweden, among them about 150 entailed estates. These big estates, to which plenty of woodland is usually attached, often have a historic background and are owned by landed gentry. There have been many Bills raised with a view to expropriate the owners and allot the land to tenants. However, no such Bills have ever been passed into law.

The smallholdings of less than 10

Silage-making is increasing in Sweden

ha. are, of course, too small to make it possible for the farmer and his family to get a satisfactory living from farming. Many smallholders work in factories and very often in the forest. The forests need labour and horses and the farm can supply both. The close connection between farming and forestry is, from an economical point of view, very fortunate. As a matter of fact, the farmers in Sweden own 53% of the total woodland; 22% belongs to the State and the rest to the industrial forest companies. Thus it is in many cases possible for the smallholder to get a total income that is equal to that of bigger farmers; the harvest is bad, the farmer can compensate himself from the woodland. However, there are many holdings too small to provide full employment and where steady employment outside the farm is not available the population of such ' incomplete ' farms is living under unsatisfactory economic and social circumstances. One of the most pressing problems in agrarian long-range planning in Sweden is the improvement of the living conditions of this rather large group.

Planned farms

The goal is to get farms of such a size that the farmer can obtain full and effective employment, so that he might mechanise his work to a reasonable extent. This work of external rationalisation, led by the Government, has been carried on since 1948. Already the number of farms of between 2 and 5 ha. has decreased by 15% during the last 10 years. There are no hard and fast rules concerning the size of the new farms; that depends on soils, type of farming etc. However, the ideal family farm is considered to be one of about 20 ha. and, if possible, including a good deal of woodland as well.

Agricultural advantages

Like all countries, Sweden has many agricultural problems. However, we already have certain advantages, of which the three following may be specially pointed out, namely:

1. Re-allotment is less of a problem in Sweden than in many other countries. In fact, the great re-allotment scheme was carried out all over the country as early as 150 years ago.

2. Sweden has very small erosion problems, *e.g.* to a small extent in the coastal areas in the southern provinces.

3. Swedish farmers have realised the need of working together. The co-operative movement in Sweden is very strong. It works on two lines: the Federation of Swedish Farmers' Association (S.L.) for marketing, to which practically all Swedish farmers belong, and the Swedish National Farmers' Union (R.L.F.), the central authority for the co-operative societies when questions of common interest to farmers are discussed. The two organisations represent the combined interest of farmers in negotiations with the Government on prices of agricultural produce.

Agricultural Zoning in U.S.A.

Agricultural zoning, to protect American farmland from the encroachment of factories and housing developments, has been introduced on the west coast and is arousing keen interest in other parts of the country, reports a recent issue of the *Journal of Agricultural and Food Chemistry*.

Preservation of agricultural land

The need for some kind of action to preserve agricultural land has been widely recognised by farm authorities, according to the American Chemical Society publication, but it was not until last summer that the first ' green belt ' was established in Santa Clara County, California. Now an Agricultural Zoning Committee, comprising representatives of both agriculture and industry, has been formed by the California Chamber of Commerce to study the problem of farmland conservation and other States may take similar action.

The problem is becoming increasingly acute, because the nation's population is gaining at a rate of two million persons a year, and food needs are increasing proportionately, while more and more farmlands are being appropriated for other purposes. Although improved technology is expected to boost farm production sufficiently to keep up with the growing population until 1975, technical advances may not be sufficient to meet the demand after that time.

It was concern over this problem which led Santa Clara County in September of 1953 to pass an amendment to its zoning ordinance, which, for the first time in the United States, provided for restricted classification of land called the ' Exclusive Agricultural ' or 'A' zone.

The new zoning provides that land more suitable for agriculture as a result of good soil be reserved for agriculture and it definitely prohibits industry, commercial development and housing from encroaching upon it. Land may be zoned for agriculture upon request of the owners after a study by the county planning commission.

Dual-Action Seed Dressings for Cereal Crops

C. P. HAMPSON, B.SC.
(British Schering Limited)

The first National Crop Protection Conference is being held at Eastbourne on 1–3 November, 1955. This Conference is being arranged by the Society of Chemical Industry in collaboration with the Ministry of Agriculture, Fisheries and Food, the Association of British Insecticide Manufacturers, the National Association of Corn and Agricultural Merchants, the British Agricultural Contractors' Association and the National Farmers' Union. The programme for this Conference includes a wide selection of crop-protection topics. Crop pests and diseases will be reviewed and methods for their control will be discussed. Particular attention is being given to the subject of seed dressings. This attention is justified, as no other agricultural practice shows a bigger return in profit for such a small cost. In this article Mr. Hampson reviews a number of different dual-action seed dressings at present available on the U.K. market and indicates that the newer preparations based on aldrin and mercury possess a number of definite advantages.

THE use of disinfectants to protect seeds against disease has been practised in one form or another for centuries. It is only in the last 10 years, however, that dual-action seed dressings have been developed to protect the crop against losses caused by both seed-borne diseases and soil insect pests. Chemically, these dual-action seed dressings for use on cereals contain an organic mercurial fungicide for the protection of the crop against such diseases as bunt of wheat, covered smut of barley, smut of oats and leaf stripe of barley and oats. In addition, they also contain an insecticide for the protection of the seedling against wireworm attack. So beneficial are the effects of the organic mercurial seed dressings in preventing the losses caused by seed-borne diseases that more than 80% of all cereals sown in the United Kingdom are dressed with one of the many proprietary seed dressings.

Wireworms

Wireworms can cause far more serious losses than seed-borne diseases and bad attacks may result in the loss of the entire crop. In the eastern counties of England during the last war 3,000 acres of newly ploughed and once-cropped grassland were kept under observation for wireworm damage; approximately 850 acres of these 3,000 yielded only half crops or less than half crops. Wireworm populations vary and serious attacks are sporadic, yet it has been estimated that on the average a quarter of the untreated cereals grown in this country suffer losses of the order of 20% due to wireworm attack.

During 1939–42 a survey, in which an attempt was made to correlate losses in crop yield with wireworm populations, was conducted in England and Wales on the effects of wireworms on food production.[1] From this survey it was estimated that, in the first year after grass, oats are reduced in yield by about 1.1 cwt. per acre for each additional 100,000 wireworms per acre and that the loss in yield is about 0.6 cwt. per acre per 100,000 wireworms in oats in the following year. For winter wheat, the losses in crop yield were estimated to amount to 1.4 cwt. per acre per 100,000 wireworms for the first year, falling to 0.7 cwt. per 100,000 wireworms the second year. No comparative figures were given for barley in the report on this survey, but it was considered that the losses caused would be less than those caused by the same population of wireworms in oats or wheat. Wireworm populations up to 600,000 per acre, against which good protection can be obtained with dual-action seed dressings, are frequent, and on today's prices the economy obtained by the use of these dressings to prevent crop losses may quite easily amount to more than £9 per acre with wheat and more than £7 per acre with oats.

Foliage and fruit pests rarely remain undetected for long, but, largely due to the absence of satisfactory methods

More than 80% of all cereals grown in the United Kingdom are dressed with one of the many proprietary seed dressings

Autumn-sown wheat; (left) *dressed with a dual-action seed dressing;* (right) *untreated, showing the damage caused by wireworms*

for their control, soil insect pests have received little attention and ' out of sight ' has been ' out of mind '. Today, however, methods of preventing the losses caused by wireworms are available and as a result the wireworm is recognised as one of the farmer's most expensive enemies.

Prevention of losses

Earlier methods for preventing losses caused by wireworm attack relied on the growing of such crops as flax and linseed, which are relatively resistant to wireworm attack, and on the avoidance of cereals and potatoes, which are seriously attacked by wireworms. This change in the cropping plan is not always desirable and other methods have been evolved to restrict the losses caused by this pest. One of these methods is to broadcast to the soil a suitably diluted dust containing a low percentage of BHC or aldrin. This form of treatment costs in the region of £4 per acre and with the BHC dust has the disadvantage that it might cause taint in root crops grown on the land in subsequent years. A newer and more economical method of restricting wireworm damage involves the use of dual-action seed dressings, which, besides giving the same protection against disease as the older seed dressings, protect the crop against all but the most serious infestations of wireworms. The cost of this combined seed treatment is in the region of only 4s. per acre.

Interesting data on the modes of action of seed treatment were obtained by Lilly[2] from a trial conducted in a greenhouse using aldrin, dieldrin and gamma-BHC seed dressings on corn. His results showed that none of the treatments gave good wireworm kill, but all gave good protection. In this trial, although 91% of the untreated seeds in the control pots was damaged by wireworm, none of the seeds dressed with aldrin or gamma-BHC was damaged. The protection afforded by dieldrin was only slightly inferior to that given by aldrin and gamma-BHC. Further trials conducted in Britain have indicated that the first effect of the insecticide in the dual-action seed dressing is a repelling one, leading the insect to look for food other than the protected seed or seedling. In the long run, however, the insecticides will kill a large number of the insects. When the surviving ones later on attack the large plants of the crop, which have then outgrown the area of protection afforded by the minute amount of the insecticide used, the root system is already large enough to be able to withstand severe damage by wireworms.

New insecticides

Until recently gamma-BHC was the only insecticide used in dual-action seed dressings, but since the discovery of the insecticidal value of BHC in 1942 other potent insecticides for the control of wireworms have been discovered; amongst these must be mentioned the chlorinated hydrocarbon insecticides, aldrin and dieldrin. Of these two, aldrin is fast becoming recognised as the leading insecticide for the protection of crops against soil insect pests, and this insecticide, together with a standard mercurial fungicide, is used in a recently introduced dual-action seed dressing called Granadin, which has this season given very satisfactory results in this country. Following Granadin, other new dual-action seed dressings which contain dieldrin instead of gamma-BHC have been introduced.

(Left) *Bunt-infected wheat grown from untreated seed;* (right) *healthy crop grown from treated seed*

So far as wireworm control is concerned, the differences between aldrin, dieldrin and gamma-BHC dual-action cereal seed dressings are not great. Gamma-BHC seed dressings have been used on a large scale for a number of years now and successful protection against wireworm attack has been obtained from their use. Similar results of highly satisfactory wireworm control have also been obtained with aldrin/mercury seed dressings. An important difference between these three insecticides is in their relative phytotoxicities, and in this respect aldrin and dieldrin are considerably safer and less likely to cause damage than gamma-BHC. This aspect of seed treatment concerning the toxic effects that some dressings may have on the germinating seed has received little attention until recently. Plain mercurial seed dressings may damage seed with too high a moisture content. The same is, of course, true with dual-action seed dressings, but, in addition to the mercury compound, the insecticidal constituent of the dressing may also affect the germination of cereal seeds. This effect on germination is not always adverse, for Cox & Lilly[3] have reported that some treatments with aldrin seed dressings slightly improved germination, and that this was most obvious in winter wheats.

TABLE 1

Variety		*Control*		*Aldrin/mercury (Granadin)*		*Gamma-BHC/mercury (a proprietary product)*		*Dieldrin/mercury (a proprietary product)*	
		*A**	*B*†	*A*	*B*	*A*	*B*	*A*	*B*
BARLEY									
Spratt Archer	Sand	85	0	87	0	0	87	97	0
	Soil					81	0		
Carlsberg II	Sand	98	0	97	0	99	0	99	0
	Soil								
Earl	Sand	98	0	99	0	98	0	96	0
	Soil								
Drost	Sand	98	0	97	0	19	80	99	0
	Soil					99	0		
Herta	Sand	98	0	98	0	31	68	98	0
	Soil					98	1		
Plumage Archer	Sand	98	0	97	0	98	0	98	0
	Soil								
Proctor	Sand	98	0	98	0	0	99	88	0
	Soil					99	0		
WHEAT									
Fylgia II	Sand	97	0	98	0	97	2	96	0
	Soil					98	1		
Atle	Sand	98	0	98	0	92	7	98	0
	Soil					99	0		
OATS									
Onward	Sand	96	0	94	0	32	66	99	0
	Soil					95	2		
Supreme	Sand	98	0	96	0	0	98	91	0
	Soil					96	0		
Victory	Sand	91	0	88	0	0	92	90	0
	Soil					84	10		
Star	Sand	98	0	97	0	12	87	98	0
	Soil					98	1		
Forward	Sand	98	0	97	0	0	98	98	0
	Soil					92	4		
Sun II	Sand	97	0	96	0	0	99	98	0
	Soil					97	0		
Blenda	Sand	99	0	99	0	0	99	99	0
	Soil					98	1		
Black Tartarian	Sand	98	0	99	0	0	99	99	0
	Soil					98	0		

*A = % normal germination.
†B = % abnormal seedlings.

Relative toxicities

In an attempt to study the relative toxicities of aldrin/mercury, dieldrin/mercury and gamma-BHC/mercury dual-action seed dressings, a number of laboratory and field trials have been conducted by British Schering Ltd. One of each of four lots of various varieties of different cereals was treated as follows:

(*a*) With an aldrin/mercury seed dressing.

(*b*) With a dieldrin/mercury seed dressing.

(*c*) With a gamma-BHC/mercury seed dressing.

(*d*) Not treated, control.

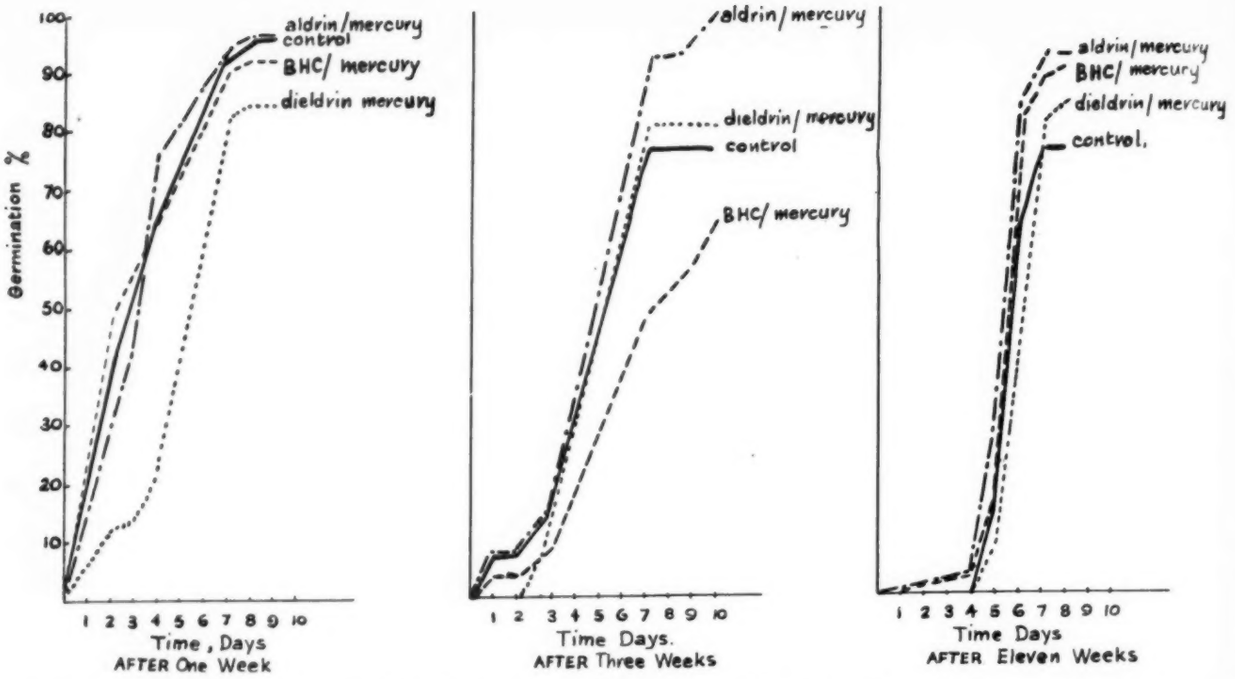
The insecticidal constituent of these seed dressings was 20% in each case and they were all applied at a rate equivalent to 2 oz. of dressing per bushel of seed. In the laboratory, the dressed seeds were sown in aluminium Petri dishes containing sterile sand and the percentage germination and also the percentage of abnormally developed seedlings were recorded. When the germination of the seeds was significantly affected, the tests were repeated, using a standard medium-loam soil. A summary of the results obtained in a large-scale laboratory trial is shown in Table 1.

It will be observed that, whereas the gamma-BHC/mercury seed dressing resulted in lower germination and abnormal seedling growth in some varieties of cereals when grown in sand, no similar adverse effects resulted from the dressing of any of the cereals tested in the trial with the aldrin/mercury or the dieldrin mercury seed dressing. When grown in the standard medium-loam soil, the gamma-BHC/mercury-dressed seeds germinated normally and only a small number of abnormally developed seedlings were recorded.

Laboratory and field trials

Laboratory germination tests for detecting possible damaging properties of different formulations are considerably more exacting than tests carried out in the field and it is therefore all the more interesting to note that even under the very sensitive conditions of these tests no damaging properties were noted in the aldrin and dieldrin formulations. These laboratory tests included trials involving the use of seeds of different moisture contents and of dressed seed subjected to varying lengths of storage. Different varieties of wheat, barley, oats and rye were used and in all these trials aldrin/mercury-dressed seed gave consistently good results and indicated that the germination of aldrin/mercury-dressed seed may even be stimulated.

The differences between the various dual-action seed dressings used in the British Schering trials were not so marked when the cereals were grown in the field. The results obtained, however, indicated that the aldrin/mercury seed dressing used on oats



The germination of Milford S.225 oats after treatment with different dual-action seed dressings and after one, three and eleven weeks' storage

gave better results than the untreated controls and the dieldrin/mercury and gamma-BHC/mercury seed dressings. A number of similar field trials have been conducted by university and Ministry authorities, and in all these trials aldrin/mercury dual-action seed dressings have given very satisfactory results with no evidence of any adverse effects on germination.

Aldrin/mercury seed dressings have been approved by the United States Department of Agriculture and results from trials conducted by universities, agricultural colleges and the N.A.A.S. (National Agricultural Advisory Service) in Britain indicate that very satisfactory results will be obtained from their use under British conditions.

In a trial conducted by the N.A.A.S., the effects of different seed dressings on winter wheat were compared and the following results were obtained, indicating that aldrin/mercury seed dressings will be very useful on winter wheat:

Control
185 plants per 40-ft. lengths of drill row

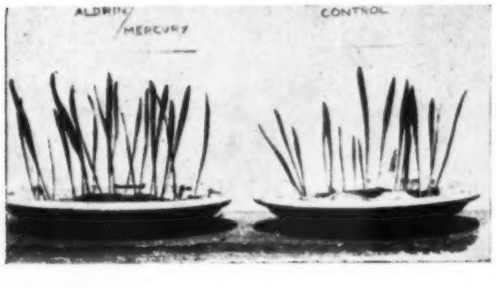
Mercury seed dressing alone
230 plants per 40-ft. lengths of drill row

Mercury/gamma-BHC dual-action seed dressing
205 plants per 40-ft. lengths of drill row

Mercury/aldrin dual-action seed dressing
322 plants per 40-ft. lengths of drill row

Conclusion

In conclusion, it can be claimed that, provided the wireworm population is not excessively high and also provided that a satisfactory seedbed is prepared, dual-action seed dressings provide an excellent method of control of wireworm damage. That these newer, recently introduced, dual-action seed dressings will have a big part to play is confirmed by the fact that this season seed for some considerable acreages of wheat, oats and barley was dressed with an aldrin/mercury seed dressing and the results obtained have been most satisfactory, with good control of wireworm and disease being achieved with no adverse effects on germination.



Milford S.225 oats grown in sterile sand. The oats on the left were dressed with 'Granadin' nine weeks before sowing; the control on the right was not dressed

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Photo: p. 450 (top), Rothamsted Experimental Station, Harpenden.

To Authors and Readers

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TECHNICAL DEVELOPMENTS IN CRANKCASE LUBRICANTS FOR TRACTORS—II

E. S. BATES, A.M.I.MECH.E., M.I.B.A.E.

Part II of Mr. Bates' article is concerned chiefly with the selection of lubricating oils for specific purposes.

TRACTOR diesel engines should be lubricated with an additive-type heavy-duty detergent oil, since this type of oil holds carbonaceous material in suspension, has a strong detergent action and resistance to oxidation, and keeps the engine clean. It also protects against piston ring sticking and against bearing corrosion.

As there is no physical property or simple laboratory test for determining the ability of an oil to keep an engine clean and to prevent ring sticking, which is the one characteristic above all that the buyer of a diesel lubricating oil is interested in, evidence of satisfactory performance can only be produced by engine testing and subsequent dismantling of the engine for examination. The accepted practice of the major oil companies is to employ a specific laboratory engine running under specific laboratory test conditions so that examinations of a comparative nature can be made on different qualities of base oils with different qualities and quantities of additives employed.

These laboratory engine tests are the same as those developed in the U.S.A. for the U.S. Army Ordnance Department. It is possible for any laboratory possessing the necessary equipment and technique to establish the performance of any lubricating oil in terms of specifications dictated by the U.S. Army Ordnance Department. This has been a useful means for bringing the oil companies into line to provide common standards of lubricating oil quality, but a ' specification ' inevitably implies minimum acceptable quality. Experience in service has shown that where oil quality exceeds such specification requirements a very enhanced performance is obtained. Therefore, the engine test methods referred to have been extended so as to provide on the market three grades of heavy-duty lubricating oil for diesel tractors. These are popularly known as heavy duty, supplement 1 and series II. They vary one from another in the quantity of detergent-dispersant additives employed, the amount being approximately doubled in each case.

All diesel tractor manufacturers recommend the use of heavy-duty oils. In a few instances, *e.g.* two-stroke diesels, tractor manufacturers need supplement oil as a normal requirement. The Caterpillar Co., whose tractors normally operate on heavy-duty oil, recommend series II oil for their tractors when using high-sulphur diesel fuel.

Having already discussed viscosity index at length, it is sufficient to say here that a high V.I. is most desirable, *e.g.* above 85 V.I.

As will be seen from Table 1, the viscosities of the oil need to be S.A.E. 20/20W and S.A.E. 30 for winter and summer use in this climate. Lower viscosity oils can be used, *e.g.* 10W, but without advantage, as there are no worthwhile savings to be made in diesel fuel costs on a ' tax free ' diesel fuel. Indeed, fractional savings here can be completely offset by increased lubricating oil consumption cost.

Petrol engines

Always assuming correct air and oil filtration, the major part of wear in a gasolene engine is due to the condensation of large amounts of water and combustion acids produced whenever a hydrocarbon fuel is burned in this way. Alkaline-type detergent additives, if present in sufficient quantities, will counteract these inorganic acids, which, if allowed to cool and condense in the crankcase, are corrosive and will form oil breakdown products leading to sludge. In this case the soot from combustion acts as a catalyst to sludge and the result is well known to all as ' mayonnaise ' sludge.

Working at a lower compression ratio, the gasolene engine takes longer to warm up than the diesel and when the tractor is used for intermittent duty may never warm up properly. The dew-point of crankcase blow-by gases is about 95° F., and if the temperature is at or below this figure, then condensation is bound to occur. This means that a cylinder jacket temperature exceeding 115° F. is necessary at all times, but obviously that cannot always be achieved. Therefore, the use of heavy-duty oils similar to those for diesel engines is becoming rapidly accepted for gasolene engines, and as these oils also tend to keep the piston clean and freedom from ring stick is assured, there is an additional benefit.

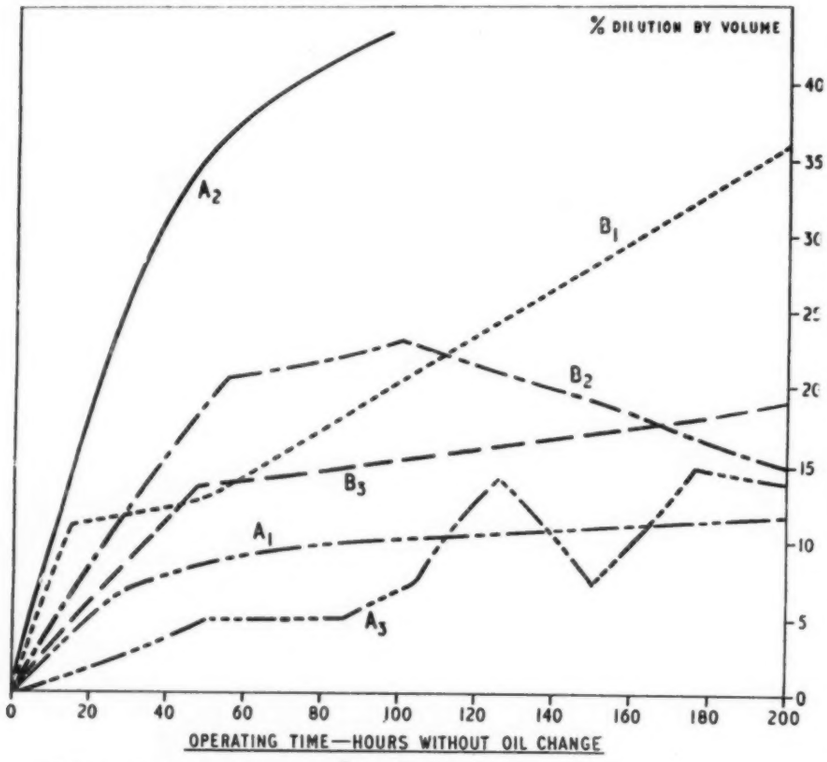
In between the heavy-duty grade and the straight mineral or regular oils for gasolene engines there is a series of oils known as Premium. Formerly, Premium oils contained only an antioxidant additive for the express purpose of preventing oil breakdown and high-temperature corrosion problems in American car engines. In tractors, however, all the gasolene engines have white-metal bearings, so that there is no bearing corrosion problem and there is little to be gained from the use of antioxidant Premium motor oils. A heavy-duty-type oil is the minimum quality acceptable for the worst cases of cold and intermittent operation. For ease of operation S.A.E. 20 and 30 grades with V.I. exceeding 80 are required.

Vaporising oil engines

Very much of what has been said in respect of the gasolene engine applies also to the vaporising oil tractor. The operating problems are similar in many respects with the one exception of crankcase dilution. Unless the engine can be so loaded that the cylinder liner surface temperature is kept above 320° F. crankcase dilution will occur. This is not achieved in practice and crankcases containing 20% of partially burnt

FIGURE. 3. CRANKCASE DILUTION BETWEEN OIL CHANGES

A.1. MANUFACTURER A. TRACTOR IN LABORATORY, CONTINUOUS WATER 175°F. AND OIL 203°F.
A.2. MANUFACTURER A. TRACTOR IN LABORATORY, CONTINUOUS WATER 104°F. AND OIL 122°F.
A.3. MANUFACTURER A. WITH SPECIAL INDUCTION SYSTEM—TRACTOR ON FARMWORK.
B.1. MANUFACTURER B. TRACTOR ON FARMWORK—LIGHT DUTIES ONLY.
B.2. MANUFACTURER B. TRACTOR ON FARMWORK.
B.3. MANUFACTURER B. TRACTOR ON FARMWORK.



NOTES
A_1 A_2 ..... 1946 MODEL. ·001"–·0015" BORE WEAR AT TIME OF TESTS.
A_3 ..... 1945 MODEL, FITTED WITH NEW PISTON RINGS AND VALVES GROUND IN PRIOR TO TESTS.
B_1 ..... 1949 MODEL WITH UP TO ·004" BORE WEAR.
B_2 ..... " " NO SPECIAL ATTENTION PRIOR TO TESTS.
B_3 ..... " " " " " " " "

vaporising oil are common even today.

Having made a long study of the problem of crankcase dilution, we now know that it begins with condensation of a small part of the fuel–air mixture on the cylinder walls during the compression stroke, that the diluent is absorbed by the oil on the cylinder wall and the unburnt portion of diluted oil passes to the crankcase. Beginning with a fresh charge of oil, dilution occurs until such time as the oil temperature, and therefore the jacket temperature also, are raised sufficiently to prevent dilution occurring on the cylinder walls and high enough to begin driving off diluent vaporising oil from the oil mixture in the crankcase. However, once the crankcase diluent has passed a figure of approximately 10% by volume, then, however hard a tractor engine is driven thereafter, the diluent will never be completely driven off and a minimum figure of approximately 10% by volume is established. It is possible then to predilute a new crankcase oil 10% v/v with kerosene, which is very similar in volatility to vaporising oil, and so obtain the impression that such an oil in service is free from dilution, because diluent in excess of 10% will be driven off whenever the temperature is high enough. This, of course, is begging the issue, because dilution is a function of engine temperature and never of oil quality. However, in comparison with the oil of relatively high viscosity recommended by tractor manufacturers, the pre-diluted oil certainly gives easier starting when the oil charge is new. But since the high-viscosity oil in its turn must become diluted, and this is very soon, its starting characteristics are soon the same as the pre-diluted oil. From that time on both the oil which has obtained its dilution naturally and the pre-diluted oil will behave inside the engine in exactly the same way (see Fig. 3). The claim for double the life to oil change period in vaporising oil engines cannot, therefore, be established on the basis of using a pre-diluted lubricating oil.

Doubling the life of lubricating oil in vaporising oil tractors is only applicable to those makes of tractor which still retain a recommended oil drain period 50% that of the corresponding gasolene engine figure. The idea of the short oil change period in vaporising oil tractors was, of course, to prevent dilution attaining high figures, thus reducing the oil viscosity abnormally. However, with the inclusion of additives in lubricating oil which act as film strength improvers, thinner oils can be used nowadays than was formerly believed possible. Experience has shown that S.A.E. 20W oils are practical and much lower viscosities with dilution have been acceptable, as we know from our tractor field-testing experience. In a few cases, tractor manufacturers have already brought the oil change period of their vaporising oil tractor up to that of the gasolene engine. This is feasible because of the knowledge just outlined and also because of improved methods of vaporisation and, lastly but not least, because of improvements in lubricating oil filtration. It stands to reason that engines whose designs are basically similar, whether for vaporising oil or for gasolene operation, cannot be differently affected by abrasives so long as the lubricating oil filters etc. are the same. Today there is no real case for keeping oil change periods half those of the gasolene engine tractor. Numerous field tests have been carried out to confirm this with both straight mineral and additive-type oils.

Further developments

As already pointed out, a degree of confusion exists in the grades and types of lubricating oil required for the farm that has more than one type of power and more than one make of tractor.

Continued on page 456

Some Aspects of the Hungarian Communist Party's New Agricultural Programme

AN interesting document for all students of agricultural development in Iron Curtain countries was published recently. This is the Hungarian Communist Party's new agricultural programme. After discounting the political verbosity of this document, which contains only a few facts of assessable value against numerous slogans, there is still the possibility that with careful analysis of the directives, and taking stock of the omissions, which are just as important when studying such documents, information about the actual state of affairs can be extracted. As it is probable that the same pattern applies to the agricultural situation in the other satellite States, and partly also to the U.S.S.R. itself, it seems to be of general interest when surveying agriculture in Iron Curtain countries as a whole.

The land-tenure system in Hungary is divided into three distinct categories: (1) State farms, (2) collective farms and (3) peasant holdings. It seems that the State farms are the most advanced. Figures show that 19% of the grain, 26% of the fat stock and 21% of milk production have been delivered by these, although they cover only 13% of the land. The target of commercial production for 1956 is set at 300,000 tons of cereals, 50,000 tons of wheat and 28 million gal. of milk for consumption. In addition, State farms have to supply the other farms with improved seeds and livestock and their set target for these items for 1956 includes a further 90,000 tons of improved seeds, 2,000 pedigree bulls, 40,000 pedigree pigs and 40,000 rams, besides taking into account that their up-to-date working methods should give a lead to all farmers. Their main deficiency seems to be in production costs and the programme urges leaders to reduce costs by all possible means and to eliminate the considerable waste.

In excess of other facilities and subsidies, 25% of the net returns can be used for new investments and 15% for production premiums to managers, workers etc.

Collective farms now cover one-third of the arable land and should increase by half up to 1960. To be able to fulfil this rather modest programme the Communist Party states that crop returns and livestock production should be raised to such an extent that members of the co-operative farms should enjoy a higher income than the free peasants.

Some further aid is promised by the programme, but apart from that very little is said about how this should be achieved. It is interesting to note, however, that, according to the programme, 1,700 to 3,500 acres seems to be the economic size of collective farms, and therefore the smaller type of 120 to 360 acres should be extended to this acreage. It can be concluded that there is an acute labour shortage in the collectives, as leaders are repeatedly urged to press members to have their whole family work with them, and this is spiced with the well-known admonition that members are spending too much of their working time in dealing with the small strip of land left for their private use as garden etc.

It has always to be kept in mind that in Hungary, just as in the U.S.S.R. and other satellite countries, the technical and agronomical supervision of the collective farms is in the hands of the tractor-machine stations. They have to do all the mechanised field work on the collective farms, as these do not own machines themselves, and their agronomists are in charge of the planning and supervision of all farming operations. The programme indicates that the mechanical outfitting of these stations has to be completed with up-to-date machines to an extent that should enable these stations to do 85–90% of the ploughing and sowing operations, 65–70% of harvesting, 50–60% of machine hoeing of root crops and of maize, and 50% of the cutting of fodder plants. Farm-area transport operations should also be mechanised to some extent. These stations are, in fact, the political and ideological centres and control the ' Socialist ' agriculture.

Free peasant holdings cover the greatest part of the agricultural land, *i.e.* 65–70%. The programme takes great pains to point out that no pressure should be used on the peasant to enter the collectives. He should do it on a voluntary basis. Assistance should be given through credits, distribution of improved seeds, pedigree livestock, and the tractor-machine stations should help as far as possible. On the other hand, measures are taken to tighten up the deliveries of compulsory quotas, for which mismanagement and lack of control are deplored.

A few points covering general policy which are of interest are as follows:

The growing of cereals is compulsory and should cover 4 million acres, which is only slightly more than the average for 1950–55 (this does not include the acreage of maize), and, following faithfully ' Big Brother's ' latest directives, has to be extended by 40% in 1956. The secret from where the 980,000 acres are to be taken is not disclosed, though the programme does include some remarks to the effect that this should be achieved rather by increasing yields of cereals and maize than by the extension of the acreage. To enable the extension of pasture and fodder production State farmers are directed to grow lucerne and red clover for seed on 7,000 acres each, and growing contracts are arranged with co-operatives and peasants for a further seed-growing acreage of 40,000 acres.

Livestock development is mainly concentrated on improvement and extension of the cattle stock. Deficiencies are seemingly very heavy and therefore the slaughter of cows above a certain number is forbidden and various subsidies are introduced for cattle holders for breeding and fat stock. The system of forward contracting with farmers and collectives gains ground. It covers nearly all plant products and is used also for livestock production. It provides for better incentives and it seems that the delivery of the products has given more satisfaction than the prevailing system of compulsory deliveries combined with surplus sales on free markets.

The exhortation to scientists to see to it that the results of their findings

should be put into practice confirms information showing that, although research workers are efficient and research stations up to date in Hungary, as they are in most of the satellite countries, their results fail as soon as it comes to the question of ' putting it over ' to the disgruntled farming community.

Summing up, it can be said that this programme seems to contain a few genuine ideas; it gives the impression of being a half-hearted attempt to adjust to Hungarian conditions one of the U.S.S.R.'s numerous efforts to hammer out a farm policy, which should keep to the Marxist pattern, but should still induce the farmer to produce more and better food for the hungry millions. It is regrettable that the planners of Hungarian agricultural policy are still unable to free themselves from the orthodox and out-of-date Moscow views, to follow up developments in other parts of the world, especially over their southern borders, for this is surely more in line with the outlook of the Hungarian farmer.

Technical Developments in Crankcase Lubricants for Tractors—II

Continued from page 454

Changes of S.A.E. grades are recommended as between winter and summer use; and again there are variations in these recommendations between manufacturers.

Future developments can do much to straighten out this confusion. There is no reason why vaporising oil, spark-ignition and diesel engines should not all use the same quality of oil. As we have seen from the preceding paragraphs, the use of additives in all three types of machine is to be recommended. Therefore, a single quality of detergent additive heavy-duty oil can be carried on the farm for all mobile and stationary engines, with the exception of engines requiring two-stroke petrol–oil mixtures. The majority of tractor manufacturers recommend the same S.A.E. grades for both diesel and gasolene engines; only the vaporising oil engine makers continue to recommend S.A.E. 40 oil in summer time. However, field experience has shown that S.A.E. 20W and S.A.E. 30 oils with even up to 30% dilution can be used satisfactorily in vaporising oil tractors, so that the old recommendation is truly an anomaly.

Therefore, we arrive at the need for a universal oil which will be an alkaline, oxidation-inhibited, surface-inhibited, detergent-type, heavy-duty oil with double bracket viscosity covering the S.A.E. 20W–30 range. More than 20,000 tractor hours of field testing in all three types of tractor have shown such an oil to be eminently suitable for its purpose. We believe that the oil of the future is a single oil for all engines on the farm.

The author wishes to thank the Chairman of the British Petroleum Company for permission to read this paper.

Chelsea College Trains Oversea Students

One of the more unique educational establishments in Great Britain is the College of Aeronautical and Automobile Engineering. The title belies its full function, for, although specialising to a large degree in training engineers for the automobile and aeronautical industries, students may concentrate on agricultural engineering, receiving a sound basic theoretical training coupled with field practice.

At present about 400 students, who come from more than 40 Commonwealth and foreign countries, are studying at the College.

The College was founded by Mr. C. H. Roberts in 1924 and is the only establishment of its kind in Britain to be run by private individuals. Its purpose then was to meet the needs of the automobile industry for men with sound education and experience of general automobile engineering combined with business knowledge and the character, ability and training for advancement to technical and administrative positions. Seven years later a department of aeronautical engineering was opened to provide the aircraft industry with the same type of trained personnel — these two departments have since been consolidated.

In 1950 agricultural engineering was added to the curriculum to supply engineers to deal with the problems introduced by the great increase in farm mechanisation.

The automobile course is the most popular and about 10% of the students choose to specialise in agricultural engineering. All students, however, receive the same thorough training in basic engineering. This is supplied at the main premises in Chelsea, where the College has its extensive workshops. Redhill, in Surrey, is the venue for practical agricultural work—the students receive instruction and practical training on agricultural implements and tractors under actual working conditions besides learning of the chemistry and physics of soils and manures, and receiving basic training in crop and animal husbandry. Neighbouring farmers are co-operative and provide many facilities for the students to gain practical experience.

The student is attached to a co-operating company for a stipulated period during his course when he is able to appreciate the varying problems met with in practice. In many cases students are offered employment with the co-operating company at the end of their training. The complete College course lasts three years.

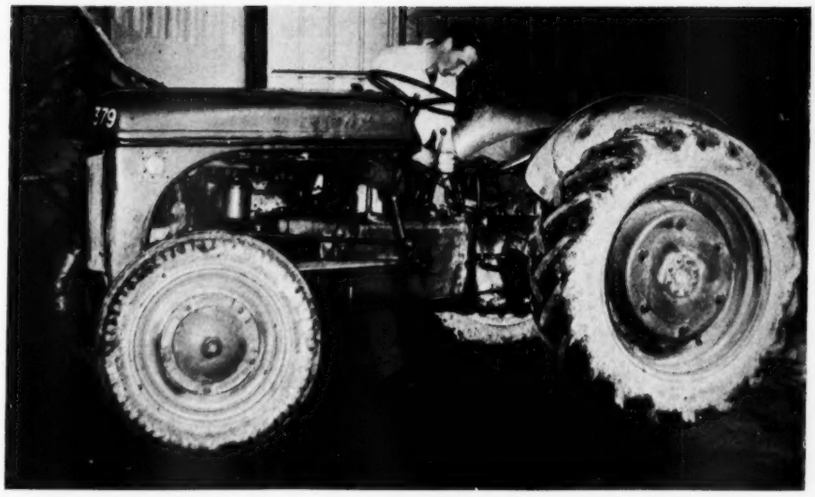
There is no restriction on the age of entry to the College, although it is considered inadvisable that students should join before attaining the age of 16 years, and only in very exceptional circumstances would applications at the age of 15 years be considered. There is no entrance examination, but students are required to pass through a probationary term of training before being considered for a full diploma training.

The diploma, awarded for a course approved by the Ministry of Education, is widely recognised as a professional asset both at home and overseas and the College has no lack of applications for enrolment; they come from all parts of the world.

The present Principal of the College, Mr. D. G. Duguid, explains that would-be entrants from overseas are almost always vouched for by responsible authorities before they are con-

sidered for enrolment. Foreign applicants are usually recommended by their embassies, and the High Commissioners of India and Pakistan check the credentials of people from those countries. West Africans are referred to their student advisory committees in Lagos or Accra before they leave West Africa. The College is assisted in every way by the Colonial Office with respect to colonial students, but the decision to accept or reject any applicant rests with the College itself.

There is no doubt that the College is an important part of Britain's technical education facilities. Its speciality is the holding of a careful balance between practical and theoretical training, and it is probably true to say that there is no other comparable institution that does this to the same extent.



A student is seen here at work on the transmission mechanism of a light tractor at the premises of the College of Aeronautical and Automobile Engineering, Redhill Aerodrome, Surrey

Ditch Maintenance

To solve the important but difficult problem of ditch maintenance a Lincolnshire firm has evolved two machines exclusively for this purpose.

One, known as the ' Ritscher ' mobile dredger, is mounted on a popular half-track tractor, using the Archimedes screw, and can form batters at the same time as it cleans all accumulated silt and weeds from the ditch. The great development which is incorporated in this dredger is that the spoil is spread automatically, the powerful centrifugal spreader breaking all silt, weeds and clay into small pieces, throwing it up to 60 ft. from the bank so that a carpet of mud is formed which is beneficial to the crops or grass and is not thick enough to cause unevenness. In practice all irregularities along the ditch bank are filled in and the cattle-trodden batters resume once more their trim. Ditches 6 ft. wide can be cleaned in one run each way or 12 ft. in two runs each way. Forward speed is about 300 yd. an hour.

The ' York ' floating dredger at work

The ' York ' floating dredger embodies the same principle of cutting, but is mounted on two pontoons which support the powerful air-cooled diesel motor. This machine requires a tractor winch for propulsion and if this is not available each dredger has its own hand winches. The ' York ' weighs 1 ton 5 cwt. and can be taken apart for easy transport. This machine will fit into a ditch of 3 ft. 6 in. top width, the adjustable pontoons allowing widths up to 8 ft. The spreader, which is the same principle as the mobile machine, throws spoil clear up to 60 ft. and thus allows ditches or rivers of up to 60 ft. to be cleaned in successive runs. It is stated that there are no weeds which cannot be dealt with and the bottom depth of 5 ft. 6 in. means that most agricultural ditches or irrigation canals can be handled.

To Aid Agriculture

Total expenditure under a co-operative five-year programme to aid agriculture in Pakistan, work on which started in 1954, is estimated at Rs. 8 million. The U.S. contribution over the past two years, including the allocation of $402,880 for the fiscal year 1955, is $837,880. The Pakistan Government have so far contributed over Rs. 2 million.

Peaceful Uses of Atomic Energy

WITHIN the space of less than a decade, applied radiation from various sources, including isotopes and reactors, has brought results in the way of new and improved varieties of various crops, according to Dr. W. R. Singleton, C. F. Konzak, Seymour Shapiro and A. H. Sparrow, of Brookhaven National Laboratory, Upton, New York (U.S.A.). In their paper, 'The Contribution of Radiation Genetics to Crop Improvement', Dr. Singleton and his associates reported to the International Conference on Peaceful Uses of Atomic Energy achievements by U.S. plant breeders through the use of radiation. They noted the development of improved strains of peanuts and oats and changes in varieties of carnations.

Recounting the development of uses of radiation in crop improvement, the authors pointed out that geneticists have been using *X*-rays (one form of atomic energy) for more than a quarter of a century to produce hereditary changes in plants. They state, however, that the science of radiation genetics got its real start in 1927 and 1928 in the U.S.A., when Dr. H. J. Muller and the late Dr. L. J. Stadler showed that *X*-rays would produce, in abundance, genetic changes in both plants and animals.

Early research work

The new science very quickly crossed the Atlantic and in Sweden in the spring of 1928 the late Dr. Herman Nilsson-Ehle, then Director of the Swedish Seed Association at Svalof and head of the Genetics Institute of Lund University, was contacted by Ake Gustafsson, one of his students and now at the Forest Research Institute, Stockholm. Gustafsson proposed to embark on an evolutionary (and also revolutionary) study of agricultural plants by means of *X*-ray- and ultra-violet-induced mutations. The thesis was that if nature continually produces mutants of value for the species, it should be possible to produce them experimentally as demonstrated by Muller and Stadler.

Mutations in barley

Tracing the history of the new science of genetic radiation in detail from this point, Dr. W. R. Singleton and his associates reported that Milsson-Ehle and Gustafsson found many mutations in barley by the use of

A small quantity of radio-active 2,4-D, a plant-growth regulator, is applied to the leaves of a bean plant to trace its absorption and use by the plant. Tests with different chemicals, which have been made radio-active in atomic reactors, are giving agricultural scientists new insight into plant growth

An agricultural scientist, safeguarded by protective clothing and a Geiger counter held near his shoulder, removes molten radio-active phosphate from a furnace. The radio-active, or tagged, fertiliser will be tested to determine how plants absorb it from the soil

X-rays. In the middle thirties Nilsson-Ehle discovered some mutants characterised by dense heads and very stiff straw. Some strains had higher yields than the parental strains, also strains shorter and taller than the parent, and also earlier and later strains.

U.S. experiments

Plant breeders in the U.S.A. began experiments following the second world war when isotopes became plentiful and the use of radiation sources more common. An outstanding development is the higher-yielding strain of peanuts, also peanuts resistant to leaf spot developed by Dr. Walton C. Gregory, of North Carolina State College at Raleigh. Another landmark is development of rust-resistant strains of oats by Calvin F. Konzak, of Brookhaven National Laboratory, and by K. J. Frey, of Iowa State College, at Ames. The group at Brookhaven changed a white carnation to red by radiation and also developed a White Sim variety of carnation with no flecks of red.

Fruit trees

Dr. Ingvar Granhall, at the Balsgard Fruit Breeding Institute in Sweden, has been successful in producing genetic changes in fruit trees.

Mutations in corn

Great differences in sensitivity to radiation are manifest as the pollen of corn develops, the authors find. By growing plants in pails in 'the portable corn field' it is possible to expose them at any desired stage in pollen development. It has been demonstrated that almost, but not quite, mature pollen is the most sensitive stage for the production of mutations. This occurs in corn about a week before pollen shedding. If other plants have similar sensitive periods, the desired mutations can be secured by exposing plants for a short time—one day or less. Hence the radiation field can be used much more efficiently for producing mutations in them and by facilitating the work of the plant breeder in helping to feed a hungry world.

Photos: U.S. Information Service, London.

To eliminate the vicious screw-worm which infests the wounds of livestock, causing many deaths, atomic radiation is used to make male worms sterile. Entomologists of the U.S. Department of Agriculture have been treating 40,000 male worms weekly and shipping them to the Caribbean island of Curacao in an effort to prevent reproduction of this livestock pest. If the experiment is successful, this new atomic method will be of value to other livestock-raising areas of the world

Vineyards and Wines Congress

The VIII International Vineyards and Wines Congress will be held in Santiago, Chile, in March 1956. More details will be published in a later issue.

Phosphate Deposit in Nyasaland

A vast deposit of calcium phosphate has been found at Natache Hill, two miles south of Lake Chilwa at the southern end of Nyasaland. A spokesman of the Department of Geological Survey said that the preliminary investigation had revealed a deposit of over 3 million tons, ' and there may be considerably more there ', he said. The phosphate was discovered last year by Government geologists who were examining pyrochlore deposits at Lake Chilwa. The ore body of apatite (calcium phosphate) is 100 ft. wide and could be quarried, which would certainly cut down working costs, said the Department spokesman. Treated with sulphuric acid apatite yields superphosphates, used as agricultural fertiliser. It also contains fluorine, but the process of extraction is difficult and would depend on large quantities of electric power being available, say, from the Shire Valley scheme.

Locust Situation

The latest locust situation report for Pakistan and adjoining countries for the fortnight ending 15 August indicates that some locust activity was shown by locust swarms in the Dera Ghazi Khan district. It was not expected to be on a large scale. Fresh egg-laying and hatching was reported from the ilaqa of Hing-loon (Buzdar Tumman) in Dera Ghazi Khan district. Control operations have been started.

In Arabia, spring breeding concluded some time ago. In Iran, the the breeding continued in May and June.

NEW PUBLICATIONS

The Genus Nicotiana

By Thomas Harper Goodspeed (*Chronica Botanica*, Vol. 16, Nos. 1–6). Pp. xxii + 536, illustrated. Waltham, Mass., U.S.A.: Chronica Botanica Co. London: W. Dawson and Sons Ltd. 1954. $12.50.

'Monumental' is the word which comes most readily to the pen in describing this work. The investigations of the genus *Nicotiana* at the University of California Botanical Garden were started as early as 1904 and the particular study of which this book is the record has occupied the author for more than 30 years. To obtain the plant material required, five expeditions have been sent out in search of members of the genus in South America. Of the 60 species here described, 56 have been grown and studied in the Botanical Garden at Berkeley, where they formed a living collection of the members of a sizeable genus so nearly complete as to merit the author's reference to it as unique.

In this work the author, as it were, dissects this genus, of which the tobacco plant is the most distinguished member. He examines each species as to its geographical distribution, its structure and its chromosomes and, using the evidence so obtained, he attempts a reconstruction of the genus, showing the origin, evolution and relationships of its member species.

An introductory chapter presents the aims of the study and lists the 14 sections into which the author divides the species. In discussing the geographical occurrence of the genus, the author shows that, despite its subsequent distribution in cultivation throughout the greater part of the world, *Nicotiana* is by origin a genus restricted to the New World, mainly to the Americas, but with some members in Australia and some islands of the Pacific. In his account of its morphology and anatomy, the author describes in detail the range of characters to be found amongst the numerous species. There is a full description of the cytology of the species and interspecific hybrids. The genus shows a range of chromosome numbers, the polyploid *Nicotiana tabacum* being one of the species with highest number.

Then follows the part of the book headed 'Phylesis', in which the author unfolds his argument as to the origin and relationships of the species and sub-genera, to which the evidence presented in the earlier chapters has been leading up. Finally, and with the collaboration of Dr. Helen - Mar Wheeler and Dr. Paul C. Hutchison, there is given a description of each of the recognised species, accompanied by a drawing showing the habit of the plant and details of leaf and flower. A list of the relevant literature occupies 18 pages.

Although the economic importance of tobacco doubtless prompted the early choice of this genus for study, the species *N. tabacum* is given no preferential treatment in this work, but is kept firmly in its place as one amongst 60 species of this good-sized genus. Its description, in fact, occupies three pages and a plate. There is considered to be no well-authenticated record of occurrence of this species in the wild state, and it is regarded as an amphiploid derived from two wild species and now forming a large accumulation of cultigens with a wide range of morphological variation and climatic tolerance.

This is, therefore, not a book on tobacco for the ordinary pipe smoker, nor will the tobacco grower learn anything here which will help to increase his profits. But for the systematic botanist, the cytogeneticist and the plant breeder there is provided a great store of information, which will repay patient sifting and careful study. The book resembles others in the series in being attractively produced, accurately printed and clearly illustrated. To at least one non-American reader some technical terms were strange and a glossary would have proved a helpful addition.

T. A. RUSSELL

Irrigated Soils: Their Fertility and Management

By D. W. Thorne and H. B. Peterson. Second edition. Pp. xii + 392, illustrated. London: Constable and Co. Ltd. 45s. net.

This is the second edition of a book first published in 1949. The fact that a second edition has been called for so soon is itself a reflection on the value and soundness of this book. In this edition the whole format of the book has been altered, and most chapters have had considerable changes introduced into them, either to clarify some points or to expand others, and to take account of new knowledge. The result is that the book contains a good accurate account of the problems of soil and crop management, and water and salt control met with in irrigation practice.

The weakest part of the text is a lack of adequate discussion on the general practices the authors are describing. It can naturally be argued that where general principles are uncertain it is better to stick to facts even if they appear to be a rather haphazard collection, but it has the disadvantage that no criteria can be given for deciding the conditions under which many of the statements made or practices described are relevant.

This edition is a better produced book than its predecessor, is free from misprints and mis-statements, and can be whole-heartedly recommended to anyone interested in the subject as a definite improvement on the first edition.

E. W. RUSSELL

Practical Plant Protection

By E. Holmes, PH.D., M.SC., F.R.I.C. Pp. xii + 252, illustrated. London: Constable and Co. Ltd. 1955. 15s.

Crop protection chemicals are essential for increased food supplies. Continuous progress is made in developing and improving these chemicals and it is difficult for even the specialist to keep abreast of the latest developments. 'Practical Plant Protection' surveys all aspects of crop protection in Great Britain and is written for the average farmer or grower who wishes to achieve maximum yields by using the most efficient and economic means at his disposal.

The author has had practical farming experience and understands the problems of the working farmer. He describes clearly and concisely the main insect pests and fungus diseases of farm, market-garden, orchard and glasshouse crops, and the best remedial measures. Many types of selective and non-selective weedkillers are discussed at length.

The book contains a great deal of practical information and a comprehensive index. There is also a bibliography of standard textbooks.

MACHINERY AND EQUIPMENT

New Traxcavator

The third traxcavator to be announced in Caterpillar Tractor Co.'s (Peoria, Illinois, U.S.A.) expanding line of tractor-shovels is the new Cat. No. 933 Traxcavator. Having a 1-cu.-yd. bucket, this newest traxcavator in the Cat. D2 crawler tractor class has been completely designed and built as an integral tractor-shovel.

All the design advantages that are incorporated in the company's larger (1½-cu.-yd. bucket) No. 955 Traxcavator have been included in this smaller version. This smaller tractor-shovel consequently includes such features as unit design, 40° bucket tilt-back at ground level, excellent horsepower-to-weight ratio, advanced hydraulic system, large lifting capacity, good balance and stability as well as operator convenience and visibility, fast response to controls, in-seat starting and oil flywheel clutch.

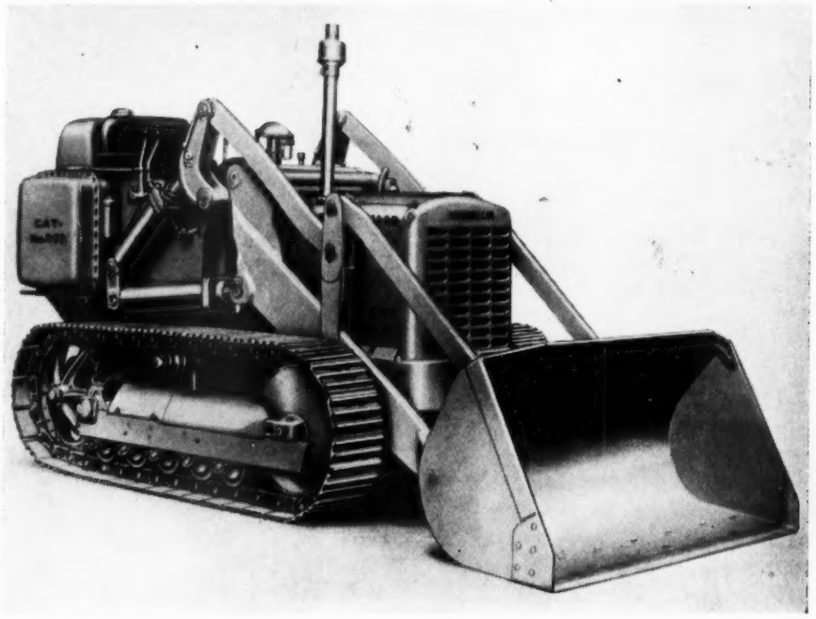
Box-section track roller frames offer greater strength and rigidity to the new No. 933. A five-roller track frame and a 54-in. gauge are used to ensure good stability and weight distribution. A 37-section track chain, using 12-in. three-bar grouser track shoes, is used on the No. 933.

A large-diameter fabricated disk-type idler is standard equipment on the No. 933. The No. 933 incorporates the same 45-gal. fuel tank as does its larger counterpart, the No. 955.

Bucket lift and tilt controls are within a hand's span of each other for utmost convenience. After dumping, a single hand motion moves both controls to return the bucket to digging position. When raising the bucket, the operator simply pulls the lift control and forgets it. An automatic kick-out moves the lever to ' hold ' at the top of the lift cylinder stroke.

The vane-type hydraulic pump is driven from the front of the engine and is of ample capacity to permit simultaneous operation of bucket controls without loss of speed or power. The control valves are mounted inside the sealed hydraulic reservoir system, protects the entire system and is located on the left fender for easy servicing.

In-seat starting employing either a gasolene starting system, equipped with 6-V. electric starting, or a 24-V. direct electric starting system is available.



Newest tractor-shovel in Caterpillar's expanding line of traxcavators is this 1-cu.-yd. No. 933 traxcavator. Integrally designed and built as a single unit rather than a shovel attachment for the D2 crawler tractor, the No. 933 is an example of excellent stability and good balance

The No. 933 has reverse speeds up to 264 ft. per min. and four forward speeds up to 528 ft. per min. which are especially desirable for shovel operation.

Overall dimensions of this 50-h.p. traxcavator are: length, 13 ft. 10 in.; width, 70 in.; height, 75¼ in.; ground clearance, 10 in.; weight, 15,750 lb.

Wet Water for Fire-Fighting

A new wet water composite pressure charge for use in first-aid fire-fighting on porous materials, such as wool, cotton, upholstery, mattresses, wood shavings, sawdust, rags, straw and hay, has been placed on the market by Nu-Swift Ltd., the fire extinguisher manufacturers, of Elland, Yorkshire, England.

In fire-fighting it has been found that plain water is handicapped by its surface tension, which may be likened to an invisible elastic skin which tries to keep the area of liquid as small as possible. Surface tension prevents or retards plain water from spreading and penetrating into porous materials, and, therefore, hinders the cooling of hot spots which, in the case of dangerous, deep-seated fires, is more important than extinction of surface flames. Otherwise, re-ignition from within may occur.

Wet water has been tested in the U.S.A. on fire-fighting and the use of wet water on deep-seated fires is said to bring about an increase of 50% compared with the fire-fighting efficiency of ordinary water.

The Nu-Swift wet water concentrate, which is of the non-ionic type, is held in the composite pressure charge in a plastic bag which is burst instantaneously and automatically when the extinguisher is operated. Claimed to be the first composite wet water pressure charge in the world, the new charge has been approved by the Fire Offices' Committee, but only for use in the Nu-Swift 2-gal. Universal (Royal Navy) extinguisher, models 1301 and 1300.

The textile, paper and woodworking industries are likely to be keenly interested in this new development; so too are farmers and householders.

All parts of the 'Quicklift' auger conveyor are jig-built to ensure interchangeability of the components

Spring Tine Harrow

A new mounted version of the Massey-Harris (Coventry, England) No. 714 spring-tine harrow has been introduced for use with all tractors fitted with Cat. 2, three-point linkage. All the advantages of a trailed harrow are retained, in particular, flexibility, strength and easy adjustments.

Designed for better penetration and hard wear, the Massey-Harris No. 714 is said to improve yields by effective cultivation and weed control. Sturdy frame and spring tines are made from the highest quality steel, fully tested for strength and durability. The sections are flexibly hinged for work on uneven ground and are protected by hardened wearing plates.

Simple lever control alters the cutting angles of the tines and adjusts working depth. Tines made of high-quality spring steel have reversible points and may be adjusted in the holders to compensate for wear.

16-Row Grain and Fertiliser Drill

The 'Somerset' 16-row grain and fertiliser drill and the grain-only drill have been designed by Dennings of Chard Ltd., Chard, Somerset, England, with a view to combining large-capacity machines capable of high-speed operation with a wide sowing range for all types of seeds, from grass and roots to beans and maize.

All-steel frames mounted on wide steel tyres enable the machines to stand up to the most rigorous conditions likely to be experienced in the U.K. or abroad.

Separate waterproof, large-capacity, steel hoppers for grain and fertiliser enable approximately 9 bushels of grain and 4 cwt. of fertiliser to be sown at one filling. An agitator is fitted in the hopper to prevent the bridging of the seed.

Grain runs

External force-feed grain-runs of aluminium alloy are fitted, which, with a three-position flap, provide an extensive sowing range with a maximum of 6¼ bushels of oats per acre. Delivery from grain-runs to tubes is visible from the tractor driver's seat. Rates of sowing are controlled by means of two hand levers, which are moved to a predetermined position on a suitably graduated quadrant.

Fertiliser mechanism

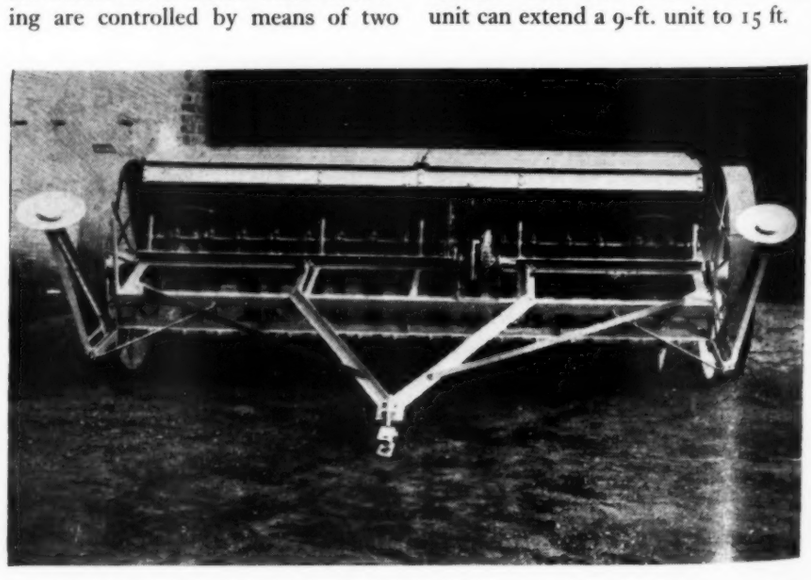
The fertiliser mechanism is based on the well-tried star-feed principle, with the stars rotating alternately clockwise and anti-clockwise, and separate rubber fertiliser tubes ensure accurate placement of fertiliser on top of the thin film of soil, which by the action of the disk has already covered the grain delivered by separate flexible non-kinking metal tubes from the grain hopper.

Two gear boxes for the fertiliser mechanism designed on the 'slide tumbler' principle give a total of 14 speeds, the gear change being operated by a single lever.

For concentrated fertiliser special low-quantity stars enable amounts down to 40 lb. per acre to be sown.

Auger Conveyor

The design of the 'Quicklift' conveyor (Opancol Ltd., 3–4 Sherwood Street, London, W.1) is new. It has many outstanding features, including cheapness; lightweight—a 9-ft. length weighs 33 lb. and a 15-ft. length 57 lb.; and its capacity 1–8 tons an hour, according to the angle and the material used. It is powered by a ½-h.p. motor and the auger itself is portable; it can be handled by one man. It is also extendable and the owner of the basic unit can extend a 9-ft. unit to 15 ft.



A self-lift is fitted to the 'Somerset' 16-row grain and fertiliser drill; it can be operated either by the tractor driver or operator on the footboard. The sowing depth can be regulated by a pre-set lever

WORLD CROP REPORTS

PARAGUAY

Cotton

Cotton production in Paraguay during the August–July 1954–55 crop year is currently estimated at approximately 62,000 bales (500 lb. gross), or about the same as the 1953–54 crop, according to S. P. Miller, American Embassy, Asuncion. Cotton acreage for the 1954–55 crop was increased by about 15% over the previous year, 173,000 acres as compared with 150,000 in 1953–54, but unfavourable weather and extensive replanting caused the crop to get a late start, thus the decline in production. Approximately half the new crop had been harvested by the end of April 1955, but no exports of new-crop cotton had been made.

Paraguay's cotton consumption averages approximately 15,000 bales annually and the balance of the crop is available for export. Exports during August–July 1953–54 amounted to approximately 57,000 bales, as compared with 43,000 in 1952–53.

ENGLAND AND WALES

Agricultural report. Agricultural conditions in England and Wales on 1 September, 1955, have been summarised by the Ministry of Agriculture, Fisheries and Food.

Good progress was made with the harvesting of corn crops; estimates of yields per acre on 1 September are generally higher than the average of the previous five years. The dry, warm weather has been unfavourable to root crops, and main crop potatoes and other roots are expected to be below average. Haymaking is finished and estimates of yields per acre are above average. Livestock have done well.

The weather during August was in the main exceptionally fine and very warm; apart from a few thunderstorms, rainfall was light.

Wheat.—Good progress was made with the cutting and harvesting of wheat under very favourable conditions. In some districts spring wheat has been somewhat slow to mature. Black rust is reported from several areas in the south-west. The quality and condition of the grain are generally good and the yield per acre is now forecast at 24.4 cwt. per acre, as compared with a five-year average (1950–54) of 22.4 cwt. and a yield of 22.6 cwt. in 1954.

Barley.—A large proportion of the barley crop has been harvested. While the condition of grain is generally good, quality is variable and reports from some districts indicate that some grain is of poor malting quality. The yield is forecast at 23.7 cwt. per acre, as compared with a five-year average of 20.6 cwt. and a yield of 21.4 cwt. in 1954.

Oats.—Good progress was made with harvesting; in eastern districts cutting was almost completed and a large proportion carted. Reports on quality show some variation, but on the whole they are satisfactory and the condition of grain is generally good. The yield per acre is forecast at 20.7 cwt. per acre, as compared with a five-year average of 19.3 cwt. and a yield of 19.2 cwt. in 1954.

Mixed corn is expected to yield 20.9 cwt. per acre, as compared with a five-year average of 19.2 cwt. and a yield of 18.4 cwt. in 1954.

Rye.—The cutting of rye is practically complete. The quality and condition of grain are good. The yield is expected to be 19.5 cwt. per acre, as compared with a five-year average of 18.2 cwt. and a yield of 18.5 cwt. in 1954.

Potatoes.—In many districts the hot, dry weather has resulted in haulms dying off prematurely and yields may be affected, particularly on the lighter soils. Blight is not prevalent and is reported from a few areas only. On present prospects the yield of second early and maincrop potatoes is expected to be 7.9 tons per acre, as compared with a five-year average of 8.6 tons and a yield of 8.4 tons in 1954.

Sugar-beet.—Sugar-beet has been slow to make growth in many areas and rain would be beneficial; black aphis and mangold fly attacks have also retarded growth. The yield per acre of roots is expected to be below average.

Turnips and swedes have been checked by very dry conditions in most areas and badly need rain. Many crops are affected by mildew, and aphis attacks are reported from several districts. The combined yield per acre is expected to be below average.

Kale.—Early-sown kale looks well in many areas, but later sowings have suffered from the drought. Damage by cabbage white butterfly is reported from several districts.

Hay.—Harvesting has been completed. The general condition and feeding quality are reported to be good. The yields of hay from *temporary grass* and *lucerne* are expected to be 32.6 cwt. and 46.7 cwt. per acre respectively, as compared with 29.1 cwt. and 42.2 cwt. in 1954 (five-year average 30.2 cwt. and 44.5 cwt.). The yield of hay from *permanent grass* is expected to be 22.7 cwt. per acre, as compared with 21.3 cwt. a year earlier (five-year average 21.2 cwt.).

Pastures.—The dry conditions were unfavourable for the growth of pastures and grass keep became scarce in several areas; ragwort is more prevalent than usual.

INTERNATIONAL

Sugar

Indonesia.—Current estimates of the 1954–55 crop remain at 850,000 tons, of which about 300,000 tons will be available for export.

In the previous 1953–54 season 720,000 tons were produced, of which about 220,000 tons were for export.

United Kingdom. — The more showery weather which occurred recently has obviously helped the crop and from the statistics, which we reproduce below, it would appear that earlier estimates of a crop below average were unduly pessimistic.

Holland.—Our friends inform us that weather conditions have been so favourable in the last few weeks that arrears in development, by comparison

Field tests	*Root weight*		*Sugar content*		*Sugar in root*	
	1955 *gr.*	1954 *gr.*	1955 %	1954 %	1955 *gr.*	1954 *gr.*
20 August	293	272	14.24	10.94	40	30
27 August	358	324	14.12	11.38	50	37
3 September ..	399	348	14.52	12.71	58	44

with previous years, may now be said to have been made up. The crop is not expected to be more than an average one, however. The plant population is rather less than normal and ' bolters ' are a very noticeable feature of some fields. Some damage has been done by aphides and virus yellows has put in an appearance, but it is not expected that the crop will be affected to any important extent. A good deal will depend on climatic conditions in the coming weeks and more especially during the weeks immediately preceding the harvest.

France.—Our friends in France suggest that the beet crop should compare closely with the out-turn last season. So far as concerns sugar content, they point out that it is unwise at this stage to hazard a forecast, as it may still vary considerably.

Spain.—Beet crops are rather disappointing this year in Seville, probably due to overworking the land with this crop in recent years, according to the Bank of London and South America.

Bulgaria.—The area under cultivation to sugar-beet this year amounts to about 33,000 ha., according to *Zeitschrift für die Zuckerindustrie*. With a yield expected to average about 17.5 tons per ha. the total beet out-turn should be approximately 577,000 tons. It is anticipated that sugar production will amount to 70,000–75,000 tons.

The area sown to sugar-beet is scheduled for considerable expansion in the next few years and it is hoped also to increase the tonnage per ha.

Taiwan.—The 1954–55 season has now closed with a sugar output amounting to 733,160 metric tons, *tel quel*, or 755,111 tons, raw value. *Taiwan Sugar* accredits the success of the crop to the extremely favourable climatic conditions experienced this year and also to improved varieties of cane.

Czarnikow Rev.

Citrus

According to figures released by the U.S. Department of Commerce, the world production of grapefruit in 1954 totalled 48,181,000 boxes of 80 lb., as against 54,111,000 in 1953. North America accounted for 44,235,000 boxes of the 1954 total, the U.S.A. being the largest producer with 42,220,000 boxes.

The world production of oranges, including tangerines, totalled 354,450,000 boxes of 70 lb., as against 354,071,000 boxes in 1953. North America accounted for 158,672,000 boxes of the 1954 total (including a U.S. output of 135,835,000 boxes) and the Mediterranean area produced 100,509,000 boxes.

The production of lemons amounted to 29,750,000 boxes of 76 lb., compared with 33,341,000 boxes in 1953. The U.S.A. was the largest single producer in 1954 with 13,800,000 boxes and the Mediterranean area produced 12,880,000 boxes.

PAKISTAN

Wheat

The third estimate of the area under wheat for the year 1954–55 is 10,533,000 acres, as against 10,283,000 acres reported in the third estimate of the previous year, and shows an increase of 2.4%. The acreage reported in the final estimate of last year was 10,651,000 acres.

By far the largest increase has occurred in the Punjab, which is attributed to sufficient moisture due to heavy rains and floods at the time of sowing.

The third estimate of the yield of this crop for the year 1954–55 is 3,144,000 tons, as against 3,331,000 tons reported in the corresponding estimate of the previous year, and shows a decrease of 5.6%. The yield reported in the final estimate of last year was 3,683,000 tons.

Except in Baluchistan and East Pakistan, there has been a decrease in the yield of this crop in Pakistan, attributed largely to insufficient rainfall and canal closures.

Rice

The final estimate of the area under rice for the year 1954–55 is 23,700,000 acres, as against 24,533,000 acres reported in the final estimate of the previous year, and shows a decrease of 3.4%.

The final estimate of the yield of this crop for the year 1954–55 is 8,405,000 tons of cleaned rice, as against 9,147,000 tons in the previous year, and shows a decrease of 8.1%.

Cotton

The supplementary estimate of the area under cotton for the year 1954–55 is 3,185,000 acres, as against 2,928,000 acres reported in the supplementary estimate of the previous year, and shows an increase of 8.8%. The increases in respect of American and Desi varieties are 4.9% and 31.1% respectively.

Major increases in the area under cotton crop have occurred in the Punjab and Bahawalpur State. In the Punjab the increase is due to extensive resowing in the Multan circle. The increase in Bahawalpur State is attributed to adequate supply of water and timely rainfall.

The supplementary estimate of the yield of this crop for the year 1954–55 is 1,596,000 bales of 392 lb. each, as against 1,442,000 bales of 392 lb. each reported in the corresponding estimate of the previous year, and shows an increase of 10.7%. The increases in respect of American and Desi varieties are 7.8% and 31.1% respectively.

Jute

The first estimate of the total area under the jute crop for the year 1955–56 is 1,716,000 acres, as against 1,304,000 acres reported in the preliminary estimate of the previous year, and shows an increase of 31.6%. The increase is attributed to an increase in the jute quota, a comparatively higher price of jute, and favourable weather conditions at the time of sowing in some major jute-growing districts. The acreage reported in the final estimate of last year was 1,150,000 acres. The area for which licences were issued is 1,546,000 acres, as against 1,231,000 acres for last year. The period covered in this estimate is from the date of sowing, *i.e.* February, up to the end of June 1955.

U.S.A.

American crop production this year is expected to be the second highest on record.

The production index for all crops based on 1 July prospects is 104% of the 1947–49 base period. This is second only to the record of 106% in 1948.

The Agriculture Department has warned, however, that optimism must be tempered by the ' considerable gauntlet of the usual adversaries—drought, heat, insects and disease ' still to be faced.